Alessandro Ferrero

Dipartimento di Elettronica, Informazione e Bioingegneria
Politecnico di Milano
Piazza Leonardo da Vinci 32
20133 Milano – Italy

E.mail: alessandro.ferrero@polimi.it

BIOGRAPHY

Alessandro Ferrero

EDUCATION

In 1973 Alessandro Ferrero enters the 5-years curriculum toward the Laurea degree in Electrical Engineering at Politecnico di Milano University.

In 1974 he gets the Proficiency in English Certificate from the Cambridge University, Cambridge, UK.

In 1978 he gets the Laurea degree in Electrical Engineering, with a graduation mark of 100/100, discussing a thesis about the design of a fully digital wattmeter, based on a simple, innovative, variable time sampling strategy that led to measure the electric active power by simply accumulating current samples.

CAREER

1980 – 1983 - **Designer** | Landis & Gyr – Daco System Division - Italy

Designer of digital protective relays. He was responsible for designing the first Italian digital distance relay. When he quitted the job to join Politecnico, the design stage was completed, and a prototype was successfully undergoing the lab tests

1983 – 1987 - **Assistant Professor** | Politecnico di Milano University – Milano - Italy

Research responsibility in the field of electrical measurements. He pioneered the application of DSP techniques to measurement on electric power systems and the characterization of electrical components and devices.

He was also responsible of teaching the lab classes of the electrical and electronic measurement subjects.

1987 – 1991 - **Associate Professor** | University of Catania – Catania - Italy

Research responsibility: He was asked to "refuel" the research activity in the field of electrical and electronic measurement. He selected and trained some of the best graduate students, and now the measurement group in Catania is one of the leading Italian Research teams in the sensor field. The team leader, and one of Alessandro Ferrero's former students (Prof. Salvatore Baglio) is the President of the IEEE Instrumentation and Measurement

Society for the 2019-2020 term, an IEEE Fellow and an Associate Editor of the IEEE Transactions on Instrumentation and Measurement.

Teaching responsibility: He taught the class of Digital Signal Processing.

1991 – 1994 - **Associate Professor** | Politecnico di Milano University – Milano - Italy

Research responsibility: He was called back to Politecnico di Milano to bring there his competence in the field of Digital Signal Processing applied to measurement, and provide new research stimuli to the local research team in the I&M field.

Teaching responsibility: He taught the class of Digital Signal Processing and a class of Circuit Theory.

1994 – present - **Full Professor** | Politecnico di Milano University – Milano - Italy

Research responsibility: He is the leader of the Politecnico's research team he has created in the I&M field. This team is presently one of the prominent Italian Research teams in the field, and is also recognized as one of the leading groups at global level.

Teaching responsibility: He is presently teaching the classes of Measurement Oriented Digital Signal Processing to graduate and Ph. D. students. In the past, he taught a class of Electronic Instrumentation to graduate students, and a class of Electrical Measurement and Electronic Instrumentation to undergraduate students.

AWARDS AND RECOGNITIONS

1986 – **Angelo Barbagelata Award**, rewarding the best paper published in the previous year in "L'Elettrotecnica" journal, that was the official journal of AEI, the former name of the Italian Association of Electrical and Electronic Engineers.

1993 – **Damien Burin Award**, rewarding the best paper in the Proceedings of the IMEKO TC-4 6-th International Symposium on "Intelligent Instrumentation for Remote and On-Site Measurements", Bruxelles, Belgium, May 12-13, 1993.

2006 – **IEEE Joseph F. Keithley Technical Field Award in Instrumentation and Measurement**, with the motivation: "For advancing the measurement of electrical quantities in electric power systems under non-sinusoidal conditions."

2011 – He has been elected Foreign Member of the of the Class of Technical Sciences of the **Royal Flemish Academy of Belgium for Science and the Arts**.

2014 – He received the title of **Doctor Honoris Causa** by the **Polytechnic University of Bucharest**, Romania

MEMBERSHIPS

AEIT – Italian Association of Electrical and Electronic Engineers. He has been a member since 1978

ANIPLA – Italian Association for Industrial Automation. He has been a member since 1990. From 1991 to 2006 he was a member of the Governing Body. He has chaired the Milano Section (the biggest Section of ANIPLA) for the 1997-1998 2-years term.

GMEE – Italian Group on Electrical and Electronic Measurement. He has been a founding member of the Association. He was the Vice President from 2001 to 2004 and the President from 2004 to 2007. He is presently the Editor-in-Chief of Tutto_Misure, the journal edited by the GMEE.

IEEE – He has been a member since 1988. Senior Member since 1996 and Fellow Member since 1999. He has been also a member of the IEEE Instrumentation and Measurement Society since 1987. He was a member at large of the Society's Administrative Committee from 1997 to 2017. He was Vice President for Publication in 2007. He was the Society President for the 2008-2009 2-years term. He was the Editor-in-Chief of the IEEE Transactions on Instrumentation and Measurement from 2012 to 2016.

AAFS – He has been an Associate Member of the American Academy of Forensic Sciences since 2016 and a Member since 2020.

COIF – Forensic Engineers Committee of the Milan Order of Engineers. He has been a member of this Committee since 2019.

EXPERTISE

Alessandro Ferrero has pioneered methods, based on advanced Digital Signal Processing techniques, for material and component characterization and power and energy metering. His work has helped improve power quality, especially for identifying sources that produce distortion and compensating for unnecessary current and power components.

In Europe, Alessandro Ferrero has led in the use of Virtual Instruments. The measurement and instrumentation technologies he developed have been used to solve complex measurement problems in electric power systems under non-sinusoidal conditions by factoring in Virtual Instruments, Digital Signal Processing and Distributed Measurement Systems.

His contributions have been recognized worldwide as fundamental milestones in measurement science and practice. These include his interpretation of power definitions based on hyper-complex algebra, as well as his landmark paper, *Definitions of Electrical Quantities Commonly Used in Non-Sinusoidal Conditions*. His work allowed him to define new indicators for evaluating supply and loading qualities under non-sinusoidal conditions. At the same time, his mathematical approach, which is based on hyper-complex algebra, has provided an easier to use and more powerful framework for modelling such conditions.

Alessandro Ferrero founded and chaired the first seven International Workshops on Power Definitions and Measurements. Sponsored by the North Italy Chapter of the IEEE Instrumentation and Measurement Society, these workshops brought together the world's top measurement and instrumentation researchers to exchange ideas and explore theoretical and practical applications in the field.

Electric Power Quality measurement, as well as measurements for the identification of the sources producing electric pollution, require complex measurement procedures and instruments, whose uncertainty is quite difficult to evaluate. Therefore, during the most recent years, Alessandro Ferrero and his research team have reconsidered the mathematical representation of a measurement result, moving from the presently employed probability theory, to the more general theory of evidence and pioneering the use of this mathematical theory for representing measurement results together with their uncertainty.

More recently, Alessandro Ferrero has started a multidisciplinary research team on Forensic Metrology, that is the application of metrology inside the Forensic Sciences, whenever measurement results are used as evidence of a crime or misconduct. This team, composed by scientists and lawyers, is aimed at showing that correct and metrology-sound results, including measurement uncertainty, are of great help to the trier of facts to render a decision "beyond any reasonable doubt", whilst measurement results, absent uncertainty, may be misleading and hide the presence of a reasonable doubt to the trier of facts.

The scientific results achieved by Alessandro Ferrero are reported in over 200 papers he has authored or co-authored, and published in the most qualified international scientific journals and in the proceedings of international conferences in the field of instrumentation and measurement. 145 papers have been published, up to date, in ISI journals. Alessandro Ferrero has an *h*-index of 31 (according to SCOPUS), which ranks him among the presently most cited scientists in the I&M field. He is the third most prolific author of the IEEE Transactions of Instrumentation and Measurement since ever.

Alessandro Ferrero is also the co-author of the book: "Digital Signal Processing for Measurement Systems -Theory and Applications", published by Springer in its series: Information Technology: Transmission, Processing and Storage, in 2006, and the co-editor of the book "Modern Measurements – Fundamentals and Applications", published by Wiley – IEEE Press, in 2015, to which he contributed with two chapters.

Alessandro Ferrero is a dedicated teacher. He has pioneered, with other colleagues, the use of virtual, web-based labs to give students round-the-clock access to real instruments from remote locations. He has founded and chaired the IEEE International Measurement University, a summer school for young engineers and Ph.D. students aimed at providing students a strong background on the fundamentals of measurement as well as the opportunity to network and form collaborations with experts in the field. Many of his students are now reputed engineers active both in Academia and Industry.

LANGUAGES

Italian – Native language
English – speak fluently and read/write with high proficiency
French – speak fluently, read with high proficiency, and write with advanced competence
Spanish – speak, read, and write with basic competence

OBJECTIVES

Alessandro Ferrero has always pursued the objective of working in a stimulating and challenging environment, where he could develop his studies and propose innovative methods for the experimental analysis and test of electric systems and components, and work to develop them into current industrial practice. He has always striven to train young, promising scientists and gather an active team of well-motivated people. One of his co-workers is now

a Fellow Member of the IEEE, three are Senior Members, and one was the recipient of the IEEE Instrumentation and Measurement Society Outstanding Young Engineer Award in 2004.

MAIN PUBLICATIONS

Papers related to measurements on electric power systems and power quality measurements (ordered from the most cited)

Title: A new approach to the definition of power components in 3-phase systems under nonsinusoidal conditions
Author(s): FERRERO A; SUPERTIFURGA G
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 40 Issue: 3 Pages: 568-577 DOI: 10.1109/19.87021 Published: JUN 1991
Times Cited: 135 (from Web of Science)

Title: A Fuzzy-Set approach to fault-type identification in digital relaying
Author(s): FERRERO A; SANGIOVANNI S; ZAPPITELLI E
Source: IEEE TRANSACTIONS ON POWER DELIVERY Volume: 10 Issue: 1 Pages: 169-175 DOI: 10.1109/61.368401 Published: JAN 1995
Times Cited: 91 (from Web of Science)

Title: A distributed system for electric power quality measurement
Author(s): Cristaldi L; Ferrero A; Salicone S
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 51 Issue: 4 Pages: 776-781 DOI: 10.1109/TIM.2002.803300 Published: AUG 2002
Times Cited: 82 (from Web of Science)

Title: Harmonic power-flow analysis for the measurement of the electric-power quality
Author(s): Cristaldi L; Ferrero A
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 44 Issue: 3 Pages: 683-685 DOI: 10.1109/19.387308 Published JUN 1995
Times Cited: 60 (from Web of Science)

Title: Definitions of electrical quantities commonly used in non-sinusoidal conditions
Author(s): Ferrero A
Source: EUROPEAN TRANSACTIONS ON ELECTRICAL POWER Volume: 8 Issue: 4 Pages: 235-240 Published: JUL-AUG 1998
Times Cited: 52 (from Web of Science)

Title: Measurement of the electric power quality and related problems
Author(s): Ferrero A; Menchetti A; Sasdelli R
Source: EUROPEAN TRANSACTIONS ON ELECTRICAL POWER Volume: 6 Issue: 6 Pages: 401-406 Published: NOV-DEC 1996
Times Cited: 37 (from Web of Science)

Title: Mathematical foundations of the instantaneous power concepts: An algebraic approach
Author(s): Cristaldi L; Ferrero A
Source: EUROPEAN TRANSACTIONS ON ELECTRICAL POWER Volume: 6 Issue: 5 Pages:

305-309 Published: SEP-OCT 1996
Times Cited: 36 (from Web of Science)

Papers related to Digital Signal Processing methods (ordered from the most cited)

Title: High-accuracy fourier-analysis based on synchronous sampling techniques
Author(s): FERRERO A; OTTOBONI R
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 41 Issue: 6 Pages: 780-785 DOI: 10.1109/19.199406 Published: DEC 1992
Times Cited: 63 (from Web of Science)

Title: A Fast, Simplified Frequency-Domain Interpolation Method for the Evaluation of the Frequency and Amplitude of Spectral Components
Author(s): FERRERO A; SALICONE S; TOSCANI S
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 60 Issue: 5 Pages: 1579-1587 DOI: 10.1109/TIM.2010.2090051 Published: MAY 2011
Times Cited: 30 (from Web of Science)

Title: A low-cost frequency-multiplier for synchronous sampling of periodic signals
Author(s): FERRERO A; OTTOBONI R
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 41 Issue: 2 Pages: 203-207 DOI: 10.1109/19.137348 Published: APR 1992
Times Cited: 29 (from Web of Science)

Papers related to uncertainty expression and evaluation (ordered from the most cited)

Title: The random-fuzzy variables: A new approach to the expression of uncertainty in measurement
Author(s): Ferrero A; Salicone S
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 53 Issue: 5 Pages: 1370-1377 DOI: 10.1109/TIM.2004.831506 Published: OCT 2004
Times Cited: 103 (from Web of Science)

Title: Camera as the instrument: the rising trend of vision based measurement
Author(s): Ferrero A; Shirmohammadi S
Source: IEEE INSTRUMENTATION AND MEASUREMENT MAGAZINE Volume: 17 Issue: 3 Pages: 41-47 DOI: 10.1109/MIM.2014.6825388 Published: JUN 2014
Times Cited: 113 (from Web of Science)

Title: Fully comprehensive mathematical approach to the expression of uncertainty in measurement
Author(s): Ferrero A; Salicone S
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 55 Issue: 3 Pages: 706-712 DOI: 10.1109/TIM.2006.873799 Published: JUN 2006
Times Cited: 55 (from Web of Science)

Title: Measurement uncertainty - Part 8 in a series of tutorials in instrumentation and measurement
Author(s): Ferrero A; Salicone S
Source: IEEE INSTRUMENTATION & MEASUREMENT MAGAZINE Volume: 9 Issue: 3 Pages:

44-51 DOI: 10.1109/MIM.2006.1637979 Published: JUN 2006
Times Cited: 47 (from Web of Science)

Title: A calibration procedure for a digital instrument for electric power quality measurement
Author(s): Ferrero A; Lazzaroni M; Salicone S
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 51 Issue: 4 Pages: 716-722 DOI: 10.1109/TIM.2002.803293 Published: AUG 2002
Times Cited: 41 (from Web of Science)

Title: A method based on random-fuzzy variables for online estimation of the measurement uncertainty of DSP-based instruments
Author(s): Ferrero A; Gamba R; Salicone S
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 53 Issue: 5 Pages: 1362-1369 DOI: 10.1109/TIM.2004.831505 Published: OCT 2004
Times Cited: 45 (from Web of Science)

Title: Modeling and processing measurement uncertainty within the theory of evidence: Mathematics of random-fuzzy variables
Author(s): Ferrero Alessandro; Salicone Simona
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 56 Issue: 3 Pages: 704-716 DOI: 10.1109/TIM.2007.894907 Published: JUN 2007
Times Cited: 42 (from Web of Science)

Papers related to Virtual Remote Laboratories (ordered from the most cited)

Title: A Web-based distributed virtual educational laboratory
Author(s): Benetazzo L; Bertocco M; Ferraris F; Ferrero A; Offelli C; Parvis M; Piuri V
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 49 Issue: 2 Pages: 349-356 DOI: 10.1109/19.843077 Published: APR 2000
Times Cited: 110 (from Web of Science)

Title: ReMLab: A Java-based remote, didactic measurement laboratory
Author(s): Ferrero A; Salicone S; Bonora C; et al.
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 52 Issue: 3 Pages: 710-715 DOI: 10.1109/TIM.2003.814695 Published: JUN 2003
Times Cited: 63 (from Web of Science)

Title: A simulation tool for virtual laboratory experiments in a WWW environment
Author(s): Ferrero A; Piuri V
Source: IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT Volume: 48 Issue: 3 Pages: 741-746 DOI: 10.1109/19.772214 Published: JUN 1999
Times Cited: 50 (from Web of Science)

Papers related to Forensic Metrology

Title: Forensic Metrology: A New Application Field for Measurement Experts Across Techniques and Ethics
Author(s): Ferrero A; Scotti V.
Source: IEEE INSTRUMENTATION AND MEASUREMENT MAGAZINE Volume: 16 Issue: 1 Pages: 14-17 DOI: 10.1109/MIM.2013.6417051 Published: FEB 2013
Times Cited: 4 (from Web of Science)

Title: DNA profiling: A metrological and signal processing perspective
Author: Ferrero A;
Source: IEEE INSTRUMENTATION AND MEASUREMENT MAGAZINE, volume: 20, Issue: 1, pages: 4-7, DOI: 10.1109/MIM.2017.786454, Published: FEB 2017
Times Cited: 1 (from Web of Science)

September 2020