

# **Modelling Control Systems Using IEC 61499**

**Applying function blocks to  
distributed systems**

**Robert Lewis**

# Modelling Control Systems Using Iec 61499 Applying Function Blocks To Distributed Systems Iec Control Series 59

**C Cleary**



## **Modelling Control Systems Using Iec 61499 Applying Function Blocks To Distributed Systems Iee Control Series 59:**

**Modelling Control Systems Using IEC 61499** Robert Lewis, 2001-04-23 The IEC 61499 standard was developed to model distributed control systems This book introduces the main concepts and models defined in the IEC 61499 standard particularly the use of function blocks covering service interface function blocks event function blocks industrial application examples and future development The book is written as a user guide for the application of the standard for modeling distributed systems and will be useful for those working in industrial control software engineering and manufacturing systems Lewis is the UK expert on two IEC working groups Annotation copyrighted by Book News Inc Portland OR *Recent Advances in Systems Safety and Security* Emil Pricop, Grigore Stamatescu, 2016-05-25 This book represents a timely overview of advances in systems safety and security based on selected revised and extended contributions from the 2nd and 3rd editions of the International Workshop on Systems Safety and Security IWSSS held in 2014 and 2015 respectively in Bucharest Romania It includes 14 chapters co-authored by 34 researchers from 7 countries The book provides a useful reference from both theoretical and applied perspectives in what concerns recent progress in this area of critical interest Contributions broadly grouped by core topic address challenges related to information theoretic methods for assuring systems safety and security cloud based solutions image processing approaches distributed sensor networks and legal or risk analysis viewpoints These are mostly accompanied by associated case studies providing additional practical value and underlying the broad relevance and impact of the field

**Fieldbus Systems and Their Applications 2005** Miguel Leon Chavez, 2006-11-23 The FeT series Fieldbus Systems and their Applications Conferences started in 1995 in Vienna Austria Since FeT 2001 in Nancy France the conference became an IFAC International Federation of Automatic Control sponsored event These proceedings focus on 13 sessions covering fieldbus based systems services protocols and profiles system integration with heterogeneous networks management real time safety dependability and security distributed embedded systems wireless networking for field applications education and emerging trends Two keynote speeches from experts outside Europe are featured The first one entitled Bandwidth Allocation Scheme in Fieldbuses by Prof Seung Ho Hanyang University Korea The second by Prof I F Akyildiz Georgia Institute of Technology USA Key Technologies for Wireless Networking in the Next Decade Featuring 36 high quality papers from 13 countries Keynote speech reflecting the current interest of wireless communications for industrial applications FeT 2005 was supported by a International Program Committee of around 40 members from 15 countries 6 from Europe

Component-Based Software Development for Embedded Systems Colin Atkinson, 2005-12-12 This book provides a good opportunity for software engineering practitioners and researchers to get in sync with the current state of the art and future trends in component based embedded software research The book is based on a selective compilation of papers that cover the complete component based embedded

software spectrum ranging from methodology to tools Methodology aspects covered by the book include functional and non functional specification validation verification and component architecture As tools are a critical success factor in the transfer from academia generated knowledge to industry ready technology an important part of the book is devoted to tools This state of the art survey contains 16 carefully selected papers organised in topical sections on specification and verification component compatibility component architectures implementation and tool support as well as non functional properties

**Contributions to Ubiquitous Computing** Bernd Krämer,2007-01-08 This book takes a holistic view on mobile and distributed computing systems It presents innovative solutions at all system layers These range from hardware over vertical and horizontal infrastructure services and novel middleware techniques to various types of application software Some chapters address core properties of ubiquitous applications including mobility self healing and self organization of both technical and social technical systems

**Distributed Control Applications** Alois Zoitl,Thomas Strasser,2017-12-19 Distributed Control Applications Guidelines Design Patterns and Application Examples with the IEC 61499 discusses the IEC 61499 reference architecture for distributed and reconfigurable control and its adoption by industry The book provides design patterns application guidelines and rules for designing distributed control applications based on the IEC 61499 reference model Moreover examples from various industrial domains and laboratory environments are introduced and explored

**Proceedings** ,2005 **Software Technologies** Marten van Sinderen,Leszek A. Maciaszek,Hans-Georg Fill,2021-07-20 This book constitutes the thoroughly refereed proceedings of the 15th International Conference on Software Technologies ICSoft 2020 which was held virtually due to the Covid 19 pandemic The 12 revised full papers were carefully reviewed and selected from 95 submissions The papers deal with the following topics business process modelling IT service management interoperability and service oriented architecture project management software scheduling and estimating software metrics requirements elicitation and specification software and systems integration among others

**Multi-Agent Energy Systems Simulation** Tiago Pinto ,João Soares,Fernando Lezama,2020-11-13 The synergy between artificial intelligence and power and energy systems is providing promising solutions to deal with the increasing complexity of the energy sector Multi agent systems in particular are widely used to simulate complex problems in the power and energy domain as they enable modeling dynamic environments and studying the interactions between the involved players Multi agent systems are suitable for dealing not only with problems related to the upper levels of the system such as the transmission grid and wholesale electricity markets but also to address challenges associated with the management of distributed generation renewables large scale integration of electric vehicles and consumption flexibility Agent based approaches are also being increasingly used for control and to combine simulation and emulation by enabling modeling of the details of buildings electrical devices microgrids and smart grid components This book discusses and highlights the latest advances and trends in multi agent energy systems simulation The addressed application topics include the design modeling

and simulation of electricity markets operation the management and scheduling of energy resources the definition of dynamic energy tariffs for consumption and electrical vehicles charging the large scale integration of variable renewable energy sources and mitigation of the associated power network issues

**Systematic Design of Distributed Industrial Manufacturing Control Systems** Martin Hirsch, 2010 Aktuell gibt es grosse neue Herausforderungen an die Hersteller von Automatisierungslosungen um die vom Markt geforderte Flexibilitat gewährleisten zu können So müssen zum Einen Spezifikationstechniken entwickelt und angewendet werden die der Komplexität verteilter Systeme gerecht werden und nicht schon in der Phase der Spezifizierung für erhöhte Verwirrung sorgen Zum Anderen müssen aber auch aktuelle Lösungen für die softwaretechnische Realisierung der Automatisierung nach und nach durch neuere flexiblere Ansätze ersetzt werden Die Möglichkeit der Verifizierbarkeit von Automatisierungslosungen sollte in diesem Kontext auch nicht ausser Acht gelassen werden In den letzten Jahren haben sich hierzu verschiedene Technologien zum modellbasierten Steuerungsentwurf herausgebildet auf welche in dieser Arbeit eingegangen wird Diese Technologien werden methodisch miteinander verknüpft um eine glatte Ingenieursarbeit ohne Bruchstellen zu gewährleisten In dieser Arbeit wird speziell auf Vorgehensweisen zum verteilten Steuerungsentwurf eingegangen die die Wiederverwendbarkeit von Steuerungskomponenten im Besonderen gewährleisten

*Bringing Innovative Robotic Technologies from Research Labs to Industrial End-users* Fabrizio Caccavale, Christian Ott, Bernd Winkler, Zachary Taylor, 2020-02-06 This book presents the main achievements of the EuRoC European Robotics Challenges project which ran from 1st January 2014 to 30th June 2018 and was funded by the European Union under the 7th Framework Programme It describes not only the scientific and technological achievements of the project but also the potential of the comparative challenge approach in robotics for knowledge advancement and technology transfer

**Industrial Applications of Holonic and Multi-Agent Systems** Vladimír Mařík, Petr Kadera, George Rzevski, Alois Zöttl, Gabriele Anderst-Kotsis, A Min Tjoa, Ismail Khalil, 2019-08-19 This book constitutes the refereed proceedings of the 9th International Conference on Industrial Applications of Holonic and Multi Agent Systems HoloMAS 2019 held in Linz Austria in August 2019 The 14 full papers presented were carefully reviewed and selected from 15 submissions and 2 invited papers were also included The papers are organized in the following topical sections invited talks methodologies and framework agent based production scheduling and control data and knowledge and MAS in various areas

**The British National Bibliography** Arthur James Wells, 2002

*IEC 61499 Function Blocks for Embedded and Distributed Control Systems Design* Valeriy Vyatkin, 2012

**Model-Driven Design Using IEC 61499** Li Hsien Yoong, Partha S. Roop, Zeeshan E. Bhatti, Matthew M. Y. Kuo, 2014-11-13 This book describes a novel approach for the design of embedded systems and industrial automation systems using a unified model driven approach that is applicable in both domains The authors illustrate their methodology using the IEC 61499 standard as the main vehicle for specification verification static timing analysis and automated code synthesis The well known synchronous approach is used as the main vehicle for defining an unambiguous

semantics that ensures determinism and deadlock freedom The proposed approach also ensures very efficient implementations either on small scale embedded devices or on industry scale programmable automation controllers PACs It can be used for both centralized and distributed implementations Significantly the proposed approach can be used without the need for any run time support This approach for the first time blurs the gap between embedded systems and automation systems and can be applied in wide ranging applications in automotive robotics and industrial control systems Several realistic examples are used to demonstrate for readers how the methodology can enable them to reduce the time to market while improving the design quality and productivity

**Modelling Control Systems Using IEC 61499** Alois Zoitl, Robert Lewis, 2014-05-30 This book provides a concise introduction to the main concepts and models defined in the standard for modelling distributed control systems for use in factory automation

**Design and Validation Environment for IEC61499 Function Blocks** Chia-han Yang, 2010 The demand for flexibility and reconfigurability in the automation industry has inspired the distributed concept in control system design The Function Blocks architecture of IEC61499 standard introduces a programming language for distributed systems design However this design approach faces two major challenges the complexity in design distributed system and the lower industrial recognition of the standard There is still lack of proper environments for design and validation based on Function Blocks Various researches have been investigating solutions to ensure the correctness and robustness of complex distributed systems such as validation and formal verification techniques for discrete manufacturing systems or hybrid continuous discrete process systems However the process of modelling everything from scratch for validation and verification purpose is time consuming and costly In this thesis a new model based engineering approach is introduced by bridging MATLAB Simulink with IEC61499 Function Block models This is achieved by two methods one is by a complete model transformation between the two block diagram languages The transformation supported by the developed tools sets the cornerstone of the verification and validation framework for IEC 61499 function blocks in closed loop with the models of the plant The framework paves the way to running distributed simulations of complex hybrid i.e continuous discrete closed loop plant controller systems and building complex models on account of object instantiation techniques of IEC 61499 The second method called co modelling approach uses communication protocols to establish direct closed loop simulation between the two models These approaches form a design and validation environment which gives an interesting alternative for designing distributed systems based on Function Blocks Bridging between popular modelling tools such as MATLAB Simulink does not just provide an easier set up for validation and verification but may also potentially improve the industrial acceptance to the IEC61499 Function Blocks

Implementation and Verification of Distributed Control Systems Christian Gerber, 2011 There exist certain key issues to modern industrial automation as modularity reusability portability flexibility extendibility and reconfigurability to create optimally coordinated automation solution for manufacturing plants This will feature the operating companies to react fast and flexible to changed

customer demands An appropriate way to realize these issues is an object oriented control implementation which has been quite common since the late 90s This work is focused on the upcoming standard IEC 61499 which defines an object oriented and event driven software model which can be realised by any hardware the engineer prefers Furthermore the control implementation is application oriented and all parts are mapped to available control devices later on Thus it is possible to replace one device by another by easily remapping the application But does this possibility need certain care during the development of the control application and how could a control engineer be supported to prove the correctness of the plant behaviour in any case To answer this question the formal model discrete timed Net Condition Event Systems is used in this work to model in a modular manner the control system and the plant Both models are connected in closed loop to perform a reachability analysis It is shown how a control engineer can examine in a graphical manner the system behaviour for all possible cases by selecting interesting trajectories and drawing them as Gantt Charts Since the model of the plant incorporates all sensors and actuators the state of the corresponding places can be included into the Gantt Chart Even if the control engineer has no deep knowledge about the used formal model this systematic and tool supported way ensures the possibility to analyse the system behaviour in any case if he changes the control application or remaps it This will reduce downtimes during production changes and new plant can be brought faster into service

*Model-driven Development of Distributed Automation Intelligence with IEC 61499* Cheng Pang, 2012 In the domain of automation and control systems the increasing use of decentralization in system architecture and the exponential growth of control complexity are drastically shifting the traditional monolithic centralized control design paradigm towards the reconfigurable distributed control engineering approaches This trend is also reflected in the development of the IEC 61499 standard for industrial process measurement and control systems Although the IEC 61499 standard proposes an open component oriented and platform independent software development framework for distributed automation and control systems its industrial recognition and practice are quite limited due to the fact that apart from the design complexity of distributed systems several core software engineering aspects of the standard are unfamiliar to most industrial practitioners and the new engineering paradigm s practical benefits are unclear to them either This thesis addresses these problems by proposing a model driven engineering methodology for the modelling and generation of distributed automation intelligence It is aimed to provide a high level development approach of distributed control systems and the corresponding simulation model generation using IEC 61499 The prerequisites to achieve this goal are a systematic modelling methodology a flexible model generator and a generic data exchange mechanism In this thesis automation and control systems are hierarchically modelled based on the concept of Intelligent Mechatronic Component IMC Each IMC is implemented as a set of IEC 61499 function blocks following the Model View Controller design pattern to enable closed loop model simulation To precisely synchronize the control logic distributed over the IMC hierarchy the Time Complemented Event Driven control architecture is proposed A knowledge based model

generator is developed to automate the generation of IMC models based on the design specifications of the automation and control systems Finally an XML based mark up language IMCML is designed to realize data unification among the heterogeneous tools and to support seamless data exchange during the proposed model driven engineering process A set of prototype tools has been developed to demonstrate the feasibility and efficiency of the methodologies presented in this thesis The tool set includes an IMCML editor and an IMC model generator for airport baggage handling systems which can be easily extended and applied for the more general material handling systems It has been shown that the ideas presented in this thesis are beneficial for existing development process and viable for practical industrial applications     *Modeling Distributed Embedded Control System and Application Code Generation Using IEC 61499 Function Blocks and XML*  
Sreenidhi Koti Ananda Rao,2004



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