Easy, Affordable and Fast Integration of IEC 61850 in Small Power System Devices

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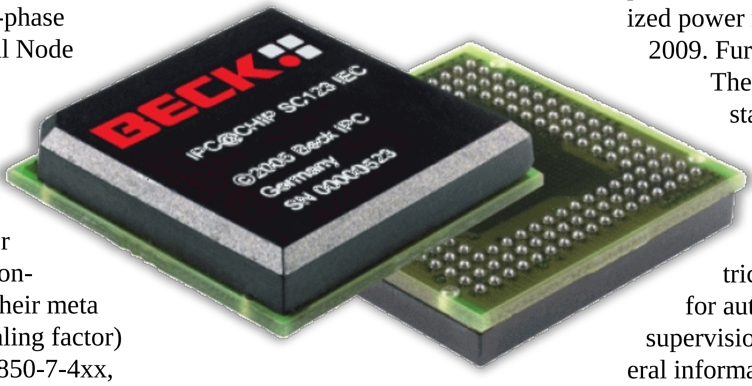
High financial and time expenditures for the implementation of IEC 61850 in control systems and other devices prevented so far a broad market penetration of the standard in the lower voltage levels and in distributed power generation. A reasonable and cost effective solution is now available with the Beck IPC@CHIP. The development of IEC 61850 conformant interfaces in power delivery systems – particularly renewable and decentralized power producers and consumers – can now be realized within very short time to market.

The standard series IEC 61850 [1] defines comprehensive information models, mechanisms for information exchange, a configuration language and a mapping to general communication protocols. It offers a unique and common architecture for many application domains [2,3]. The aspects are mainly the following:

General and user-specific information models like measured values of the voltage of the three-phase electrical network (Logical Node MMXU), rotor speed of a wind turbine (WTUR), switching position of the circuit-breaker (XCBR), temperature measured value (STMP) or the values of a PID loop controller (FPID) as well as their meta data (like SI-Units and scaling factor) are in the focus of IEC 61850-7-4xx, IEC 61850-7-3 and IEC 61400-25-2) [4-7].



Abstract methods for the change of information (ACSI - abstract communication service interface, according to IEC 61850-7-2) offer the most crucial services for the direct access (Read, Write, and Control), Reporting (spontaneous and cyclic; with monitoring of limits and changes), sequences of events (SoE: Sequence OF events), event archives in the devices (Logging), control, configuring and retrieving the self-description of the devices (IEC 61850-7-2 and IEC 61400-25-3) [8,9]. In addition two methods are defined for the transmission of critical information in real time: for the fast exchange of sensor data (typical several thousand sampled values per second of currents and voltages) and the fast exchange of critical information within the millisecond range.

Mapping of the abstract information and exchange methods to the application layer protocols as defined in IEC 61850-8-1, IEC 61850-9-1, IEC 61850-9-2, and IEC 61400-25-4 [10-13]. The communication stacks for transferring the messages use among other protocols mainly TCP/IP and Ethernet (IEC 61850-8-1 and IEC 61400-25-4).

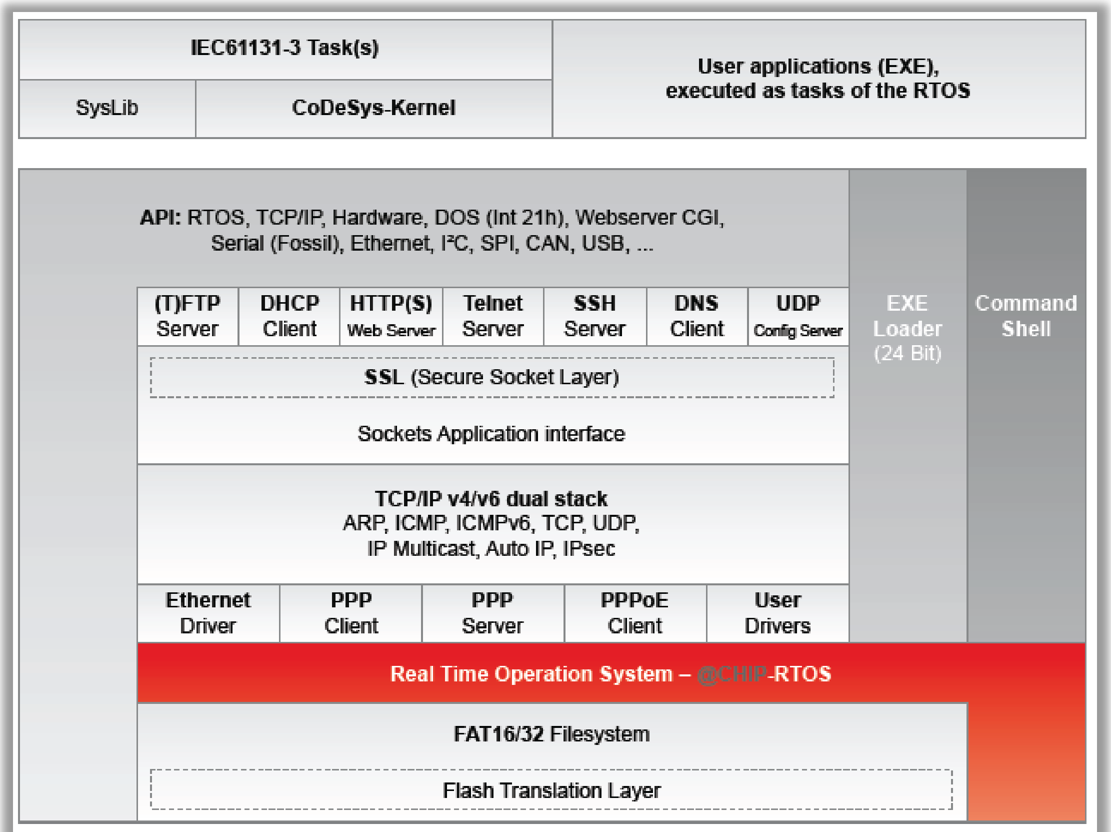
XML based configuration language for the complete description of a plant (IEC 61850-6) and a single device: Description of the plant topology, communication, information models, linkage of sources of information to destinations, and the binding of the models to the process and to internal equipment structures [14].

Toolbox for Multivendor systems

The standard series consists of 14 parts; published between 2003 and 2005. It is a tool box for building multivendor systems for substation protection and automation. The first extensions were published in 2007 in IEC TC 88 (Wind Turbines) with IEC 61400-25-4 for wind power plants. Extensions for hydro-electric power plants in 2007 and for the decentralized power resources followed in 2009. Further parts are in process.

The first fourteen parts of the standard series and the extensions (above all the information models) cover crucial information needed in the electrical power supply network for automation, protection and supervision. Meanwhile many general information models for the applications in general automation domains are defined in the second edition of part IEC 61850-7-4. One of the most crucial and interesting parts is part IEC 61850-90-7 (IEC 61850 object models for inverters in distributed energy resources (DER) systems).

The issue of the information exchange by means of MMS (Manufacturing Message Specification - ISO 9506) and ASN.1 (Abstract Syntax Notation 1 - ISO 8824/8825) – although it is required in the communication stacks of devices – however it is of subordinated importance, if it concerns the contents of the standards. With the realization of standard-



IPC@CHIP® RTOS architecture

conformant products MMS is key because before two devices can communicate in the client-server relation there is a need of an MMS stack on each end of the communication channel – a server and a client.

Applications of IEC 61850

IEC 61850 is used globally in many thousand plants of medium and high voltage networks. All large manufacturers of substations such as ABB, AREVA, GE, Siemens, Toshiba and many smaller manufacturers use IEC 61850 as the preferred solution. In the context of many Smart Grid projects in North America, in Asia and Europe IEC 61850 is regarded as the most important protocol standard. Beyond that, IEC 61850 – particularly because of the uniform and recently defined general information models – is used increasingly also in industrial and process automation systems.

In the contrast to the fieldbus standard IEC 61158 with (too) many standardized solutions in a single standard with almost 100 parts, IEC 61850 has only one protocol stack for TCP/IP-based client-server communication and two simple protocols using native switched Ethernet for real time communication. In many enterprises IP networks are very common. This allows directly and without special modifications to directly employ MMS based client-server communication. All information models of all devices can be accessed this way, fast and without detours from everywhere – also safely with TLS (Transport Layer Security). TLS is required by IEC 61850-8-1 and selected in IEC 62351 – the sister standard of IEC 61850.

These solutions could be achieved so far mostly just by very high financial and temporal expenditures. The implementation of the MMS client-server stack was usually realized by purchasing extensive and relatively expensive licensed software packages. The expected expenditures for porting the licensed MMS software and/or the development of MMS software were estimated so high that in many cases the application of IEC 61850 was questioned – especially when it comes to small devices.

Although the focus of the application of the standard series clearly is on the models and configuration language (which are independent of MMS), the implementation mainly depends on the acceptance of MMS. This is especially true for the use of IEC 61850 in simpler applications. MMS is however necessary for standard-conformant information exchange between clients and servers – no question. IEC 61850 does not support alternative protocols fortunately! The question is now, are there alternative MMS implementations – above all – for the application of IEC 61850 for simple applications? Yes! Thanks to the efforts taken by SystemCorp (Bentley, Western Australia) [15] and Beck IPC (Pohlheim, Germany) [16] to implement IEC 61850 on a small footprint of a simple embedded controller: IEC61850@CHIP.

Chip based solution

At the Hanover fair 2010 Beck IPC presented the integrated solution for IEC 61850 successfully in co-operation with SystemCORP Pty Ltd. (Bentley, Western Australia) at the Beck IPC booth. The embedded controller demonstrated was an industrial proven component that is on the market for five years in industrial automa-

tion systems. It is a modular controller chip (IPC@CHIP). The resonance of the many hundred booth visitors exceeded expectations of all involved people of Beck and SystemCorp by far. In the meantime there are many applications all over that use the Beck IPC controller.

The substantial advantage of the embedded controller based solution is its high efficiency, performance, and the minimum expenditure needed for the implementation of IEC61850-based interfaces for clients and servers. This platform is very economical. From a programming point of view it is a PC and a PLC (programmable logic controller) – it can be programmed with C/C++ as well as with IEC 61131-3 (CoDeSys). All license costs for the compilers and the IEC 61850 communication stack and API (application program interface) are already included in the chip price. Products based on other stacks may require a run-time license fee for the IEC 61850 stack per device that is more expensive than the complete chip. Not to speak about the needed efforts of porting the stack software to your platform (HW and SW). This may take many months and even years – the author has been contacted by many companies that complained that IEC 61850 is quite complex and too expensive to implement (even when using available third party software).

The IPC@CHIP SC123 and SC143 are equipped with the real-time and multitasking operating system IPC@CHIP-RTOS. The following software functions are integrated in the RTOS of the SC123/SC143: IEC 61850, IEC 61400-25, TCP/IPv6/IPv4, SSL, SSH, IPSec, PPPoE, API for CAN, IEC 61131-3 (CoDeSys, PLC), and C/C++

The software architecture is very comprehensive, compact and extremely efficient (Figure above).

The technical specification of the Chips (SC123 und SC143) could be found in the attached document.

For different applications regarding simple integration, mass production and performance three packages are offered.

IEC 61850 lite implementation

All crucial data models, communication services and the device configuration language (SCL) are realized in the stack and API running on the chip. All models from the applications protection and automation substations of any voltage level including power generation and distribution, monitoring of the power quality, automation and monitoring of hydro-electric power plants, wind turbines, decentralized energy generation such as photovoltaic, combined heat and power, diesel generators, battery storage stations, car charging stations to name just a few. The models of the new part IEC 61850-90-7 [17] are supported. The models for PV inverter have already been implemented on the SC143 by major PV inverter vendors in 2010 and 2011.

All models needed for the applications can be uploaded by a standardized SCL files by ftp on the chip. Thus the model and communication configuration is entirely accomplished by a standardized IEC 61850-6 file (SCL – system configuration language).

The IEC 61850 software stack and API can be started by the application easily as client or as server. Both applications can co-exist on the IPC@CHIP at the same time. The stack supports IEC 61850 services inclusive GOOSE and transmission of sampled values.

The SystemCorp IEC 61850 stack and API offers a very simple interface to the application software in the form of a few calls (and call-backs) like for example "Read", "Write", "Update", and "Control". Only a binding table must be defined, with which the real values of the process or of the application are bound (linked to) the information models according IEC 61850. This table is used, in order to describe the appropriate relations between model and the real world. That relation is implemented in the SCL file by private XML elements, which are interpreted by the IEC 61850 stack and API software as well as by the application software. This model (SCL file) is used for the configuration of the server **and** the client. The API documentation is available online [18]. A video explaining the use of the API function calls and the models at the server and the client side is available [19].

All services like Read, Write, Reporting, GOOSE, data sets and so on are completely configured by a SCL file. Using the same application data, one can configure at any time further logical devices, control blocks and data records simply by an extended or new SCL file transferred to the chip.

Ready to go devices

Beside the chips Beck IPC offers also ready to go modules (com.tom) – the only need is to let your application code understand the few API calls and call-backs – that's all you need to communicate your data values with IEC 61850 models and services. The development of different gateways to, for example, CAN, IEC 60870-5-10x,

Profibus, DNP3 or Modbus can be realized in short time. This reduces the time to marked tremendously. The modules can be equipped with a data base system which implements the binding of different protocols by configuration software which is based on a Windows configuration tool. Protocol stacks for IEC 60870-5-101/104/103 and DNP3.0 are likewise available.

The com.tom solution for telecontrol is suitable for applications with existing WAN connectivity and existing process control and monitoring applications. Communication of the com.tom BASIC solutions can also directly communicate with a dedicated Web portal. The com.tom communicates with Ethernet and other existing network infrastructures like WiFi, Bluetooth, or GPRS.

The communication with the process can be realized over a serial interface or over digital inputs or outputs. The digital inputs and outputs can be processed additionally with simple PLC functions.

The integrated Web server on the com.tom BASIC provides also a simple WEB based editor for a Web PLC that can be used to for simple control algorithms.

Development Kit Beck IPC DK61

For a cost effective and fast start into the world of IEC 61850 the development kit DK61 is likely the best approach.

The IPC@CHIP DK61 development kit is a complete development system for the embedded controller IPC@CHIP SC123 and SC143.

It contains the Paradigm C/C++ compiler with IPC@CHIP RTOS debugger and many further tools, which can be applied for the simplified development of C/C++ and IEC 61131-3 (CoDeSys) applications on the Embedded controller SC123 and SC143.

Despite the comprehensive hardware of the development board, which makes all interfaces of the SC123 and SC143 available, a start-up is possible within minutes rather than hours or days. This is due to the installed RTOS, the „Getting Started“ manuals and the examples that come with the DK61 development kit.

The extensive hard and software equipment allow a fast and efficient development of customized applications within hours and days.

All aspects of the IEC 61850 Solution on the IPC@CHIP, described above, are available and directly applicable also on the development kit. An extensive example of use with a model for process values (inputs and outputs), with reporting and GOOSE is contained in the kit. The source code of the C application program is likewise provided. C programmers can immediately begin with the programming of their application and – as described in the example – communicate their data values within a short time by IEC 61850.

Special knowledge of MMS and ASN.1 is not necessary – applications can directly use the simple API. The development of an extensive protocol stack and a user interface are not needed – the focus is now on the application of the standard series for the realization of smarter power delivery systems.

The SystemCorp stack and API is available on various embedded controller platforms, e.g., Arm 9 or Arm 11 controllers that run on Linux. The stack and API could be ported to all major platforms; DLLs and libraries for Windows and PCs are also available.

Reduce time to market

Using the approaches of SystemCorp (Lite Implementation and API) and Beck IPC (embedded controller with everything ready-to-go) will help you **control**, **predict** and **reduce** your **time to market**. If the market requires IEC 61850 integrated, e.g., into your PV converter or other devices for controlling or monitoring the electrical system (or other applications) there are several approaches (depending on the time to deliver the device to the customer) you could choose from:

Very short time to market
(week(s) up to a very few months):
Recommended to use the Beck IPC com.tom ready-to-go box with Beck IPC chip as external or internal module.

Short time to market
(few months):
to use the Beck IPC Chip on a small printed circuit board as internal module.

Longer time to market
(several months):
to use the SystemCorp software on the controller of an available design or design a new HW with a new powerful embedded controller, e.g., from Beck (running RTOS) or TQ (running Linux).
In the attachment there is a description of the path to a short time to market using the SystemCorp stack and API.

Further information

More information on the IPC@CHIP can be found in English and German:
http://www.beck-ipc.com

Details of the IEC 61850 Stack and API implemented on the IPC@CHIP are available at:
http://systemcorp.com.au/PIS10API

General information, trends and news on IEC 61850:
http://blog.iec61850.com

Monitoring and Control of Power Systems and Communication Infrastructures based on IEC 61850 and IEC 61400-25 (English):
http://www.nettedautomation.com/download/pub/DT-Tampa-Paper_2010-03-24.pdf

User Groups:
http://www.iec61850.ucaiug.org
http://www.USE61400-25.com

[1] IEC 61850: Communication networks and systems for power system automation. Some 20 parts by end of 2011:
http://blog.iec61850.com/2012/01/status-of-parts-of-iec-61850-series.html

[2] IEC 61850 on a page (English):
http://www.nettedautomation.com/standardization/IEC_TC57/WG10-12/iec61850/What-is-IEC61850.pdf

[3] Video on the basics of IEC 61850:
http://blog.iec61850.com/2012/02/video-with-brief-introduction-to-iec.html

[4] IEC 61850-7-410: Communication networks and systems for power utility automation – Part 7-410: Hydroelectric power plants – Communication for monitoring and control.

[5] IEC 61850-7-420: Communication networks and systems for power utility automation – Part 7-420: Basic communication structure – Distributed energy resources logical nodes.

[6] IEC 61850-7-3: Communication networks and systems in substations – Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes.

[7] IEC 61400-25-2: Wind turbines – Part 25-2: Communications for monitoring and control of wind power plants – Information models.

[8] IEC 61850-7-2: Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI).

[9] IEC 61400-25-3: Wind turbines – Part 25-3: Communications for monitoring and control of wind power plants – Information exchange models.

[10] IEC 61850-8-1: Communication networks and systems in substations – Part 8-1: Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3.

[11] IEC 61850-9-1: Communication networks and systems in substations – Part 9-1: Specific Communication Service Mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link.

[12] IEC 61850-9-2: Communication networks and systems in substations – Part 9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3

[13] IEC 61400-25-4: Wind turbines – Part 25-4: Communications for monitoring and control of wind power plants – Mapping to communication profile.

[14] IEC 61850-6: Communication networks and systems for power utility automation – Part 6: Configuration description language for communication in electrical substations related to IEDs.

[15] System Corp Pty Ltd, Bentley, Western Australia: http://systemcorp.com.au

[16] Beck IPC GmbH, Pohlheim: www.beck-ipc.com

[17] IEC 61850-90-7: IEC 61850 object models for inverters in distributed energy resources (DER) systems (to be published early 2012) http://blog.iec61850.com/2011/08/pv-power-to-destabilize-european-power.html

[18] API online documentation: http://systemcorp.com.au/PIS10API

[19] Video on the use of SCL files for configuration of a server and a client: http://blog.iec61850.com/2012/02/video-on-use-of-iec-61850-6-scl-to.html

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Dipl.-Ing. Karlheinz Schwarz (president of Schwarz Consulting Company, SCC, and owner of NettedAutomation GmbH; Karlsruhe/Germany) specializing in distributed automation systems. He is involved in many international standardization projects (IEC 61850 – utility automation, DER, hydro power, IEC 61400-25 – wind power, IEC 61158 - Fieldbus, ISO 9506 – MMS, …) since 1984. He is engaged in representing main industry branches in the international standardization of real-time information modeling, configuration, and exchange systems. Core services are consulting and training of utility personal, system integrators, consultants, and vendors. He has educated more than 2,750 experts from more than 700 companies and more than 70 countries. The training courses are considered to be outstanding. Mr. Schwarz is a well-known authority on the application of mainstream information and communication technologies in the utility industry and general automation domain.

NettedAutomation GmbH
Information & Communication Systems

Annex:

What does IEC 61850-90-7 (IEC 61850 object models for inverters in distributed energy resources (DER) systems) provide?

The following is based on IEC 61850-90-7 (final draft 2012-02)

The main purpose of the document is to define **information models** of the known functions of PV inverters. These functions are those that are **already implemented** in today's controllers of inverters installed all over. The information models defined in IEC 61850-90-7 just define **standard names** of the "signals" found in most PV inverters – the standard just follows the market. The standard also provides a **common way to access and distribute the information** needed to configure, control, and monitor real inverters. Due to the single model and communication profile (independent of the vendors) it is easy to communicate with the inverters of many different vendors with one single standard.

The advent of decentralized electric power production is a reality in the majority of the power systems of the world, driven by the need for new types of energy converters to mitigate the heavy reliance on non-renewable fossil fuels, by the increased demand for electrical energy, by the development of new technologies of small power production, by the deregulation of energy markets, and by increasing environmental constraints.

These pressures have greatly increased the demand for Distributed Energy Resources (DER) systems which are interconnected with distribution power systems, leading to high penetrations of these variable and often unmanaged sources of power. No longer can they be viewed only as "negative load". Their large numbers, their unplanned locations, their variable capabilities, and their fluctuating responses to both environmental and power situations make them difficult to manage, particularly as greater efficiency and reliability of the power system is being demanded.

This paradigm shift in management of power systems can be characterized by the following issues:

The numbers of interconnected DER systems are increasing rapidly. The advent of decentralized electric power production is a reality in the majority of power systems all over the world, driven by many factors:

- The need for new sources of energy to mitigate the heavy reliance on externally-produced fossil fuels.
- The requirements in many countries and US states for renewable portfolios that have spurred the movement toward renewable energy sources such as solar and wind, including tax breaks and other incentives for utilities and their customers.
- The development of new technologies of small power production that have made, and are continuing to improve, the cost-effectiveness of small energy devices.
- The trend in deregulation down to the retail level, thus incentivizing energy service providers to combine load management with generation and energy storage management.
- The increased demand for electrical energy, particularly in developing countries, but also in developed countries for new requirements such as Electric Vehicles (EVs).
- The constraints on building new transmission facilities and increasing environmental concerns that make urban-based generation more attractive.

These pressures have greatly increased the demand for Distributed Energy Resources (DER) systems which consist of both generation and energy storage systems that are interconnected with the distribution power systems.

DER systems challenge traditional power system management. These increasing numbers of DER systems are also leading to pockets of high penetrations of these variable and often unmanaged sources of power which impact the stability, reliability, and efficiency of the power grid. No longer can DER systems be viewed only as "negative load" and therefore insignificant in power system planning and operations. Their unplanned locations, their variable sizes and capabilities, and their fluctuating responses to both environmental and power situations make them difficult to manage, particularly as greater efficiency and reliability of the power system is being demanded.

At the same time, DER devices could become very powerful tools in managing the power system for reliability and efficiency. The majority of DER devices use inverters to convert their primary electrical form (often direct current (dc) or non-standard frequency) to the utility power grid standard electrical interconnection requirements of 60Hz or 50Hz and alternating current (ac). Not only can inverters provide these basic conversions, but inverters are also very powerful devices that can readily modify many of their electrical characteristics through software settings and commands, so long as they remain within the capabilities of the DER device that they are managing and within the standard requirements for interconnecting the DER to the power system.

DER systems are becoming quite "smart" and can perform "autonomously" most of the time according to pre-established settings or "operating modes", while still responding to occasional commands to override or modify their autonomous actions by utilities and/or energy service providers (ESPs). DER systems can "sense" local conditions of voltage levels, frequency deviations, and temperature, and can receive emergency commands and pricing signals, which allow them to modify their power and reactive power output. These autonomous settings can be updated as needed. To better coordinate these DER autonomous capabilities while minimizing the need for constant communications, utilities and ESPs can also send schedules of modes and commands for the DER systems to follow on daily, weekly, and/or seasonal timeframes.

Given these ever more sophisticated capabilities, utilities and energy service providers (ESPs) are increasingly desirous (and even mandated by some regulations) to make use of these capabilities to improve power system reliability and efficiency.

Inverter configurations and interactions

Bulk power generation is generally managed directly, one-on-one, by utilities. This approach is not feasible for managing thousands if not millions of DER systems.

DER systems cannot and should not be managed in the same way as bulk power generation. New methods for handling these dispersed sources of generation and storage must be developed, including both new power system functions and new communication capabilities. In particular, the "smart" capabilities of inverter-based DER systems must be utilized to allow this power system management to take place at the lowest levels possible, while still being coordinated from region-wide and system-wide utility perspectives.

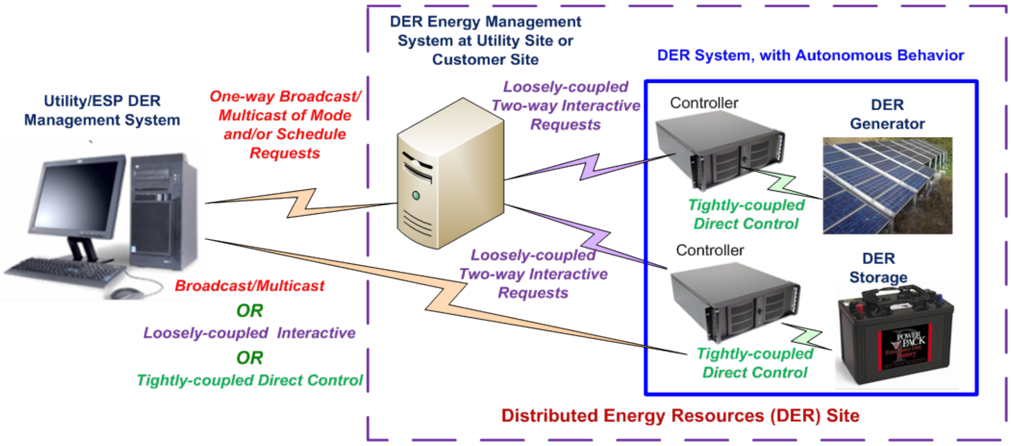
This "dispersed, but coordinated intelligence" approach permits far greater efficiencies, reliability, and safety through rapid, autonomous DER responses to local conditions, while still allowing the necessary coordination as broader requirements can be addressed through communications on an as-needed basis. Communications, therefore, play an integral role in managing the power system, but are not expected or capable of continuous monitoring and control. Therefore the role of communications must be modified to reflect this reality.

Inverter-based DER functions range from the simple (turn on/off, limit maximum output) to the quite sophisticated (volt-var control, frequency/watt control, and low-voltage ride-through). They also can utilize varying degrees of autonomous capabilities to help cope with the sophistication.

At least **three levels of information exchanges** are envisioned:

- **Tightly-coupled interactions** focused on direct monitoring and control of the DERs with responses expected in "real-time".
- **Loosely-coupled interactions** which request actions or "modes" that are interpreted by intelligent DER systems for undertaking **autonomous reactions** to local conditions or externally provided information. Information is then sent back on what actions they actually performed.
- **Broadcast/multicast** essentially one-way requests for actions or "modes", without directly communicated responses by large numbers of DERs.

These different DER management interactions are shown in the following figure.



DER Management: Interactions between Components

Inverter functions

Inverter functions range from the simple to the complex. Most inverter functions are based on settings or curves that allow them to respond autonomously to local conditions, while some require direct control commands:

- **Immediate control functions** for inverters
  - Function INV1: connect / disconnect from grid
  - Function INV2: adjust maximum generation level up/down
  - Function INV3: adjust power factor
  - Function INV4: request active power (charge or discharge storage)
  - Function INV5: request action through a pricing signal

- **Volt-var management modes**
  - Volt-var mode VV11: available vars mode with no impact on watts
  - Volt-var mode VV12: maximum var support mode based on maximum watts
  - Volt-var mode VV13: static inverter mode based on settings
  - Volt-var mode VV14: passive mode with no var support

- **Frequency-watt management modes**
  - Frequency-watt mode FW21: high frequency reduces active power or low frequency reduces charging
  - Frequency-watt mode FW22: constraining generating/charging by frequency
  - Frequency-watt mode FW23: watt generation/absorption counteractions to frequency deviations

- **Dynamic reactive current support during abnormally high or low voltage levels**
  - Dynamic reactive current support TV31: volt-var support during abnormally high or low voltage levels

- **Functions for "must disconnect" and "must stay connected"**
  - "Must disconnect" MD curve
  - "Must stay connected" MSC curve
  - Reconnect settings

- **Watt-power factor management modes**
  - Watt-power factor WP41: feed-in power controls power factor (parameters)
  - Watt-power factor WP42: feed-in power controls power factor (curves)

- **Voltage-watt management modes**
  - Voltage-watt mode VW51: smoothing voltage deviations by watt management
  - Voltage-watt mode VW52: charging by voltage

- **Non-power-related modes**
  - Temperature-function mode TMP: ambient temperature indicates function
  - Pricing signal-function mode PS: pricing signal indicates function to execute

- **Parameter setting and reporting**
  - Function DS91: modify inverter-based DER settings
  - Function DS92: event/history logging
  - Function DS93: status reporting
  - Function DS94: time synchronization

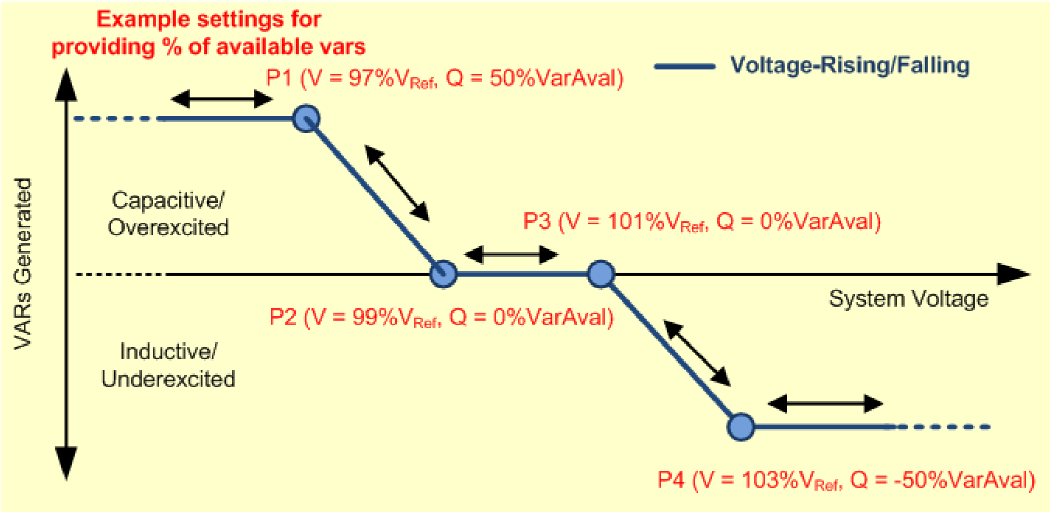
It is expected that additional functions will be added in the future, for instance for handling intentional and unintentional islanding.

The following figure provides an example of volt-var settings for this mode. It is assumed that the var value between VMin and V1 is the same as for V1 (shown as 50% VArAval, in this example). The equivalent is true for the var value between V4 and VMax (which is assumed to be 50% VArAval in this example).

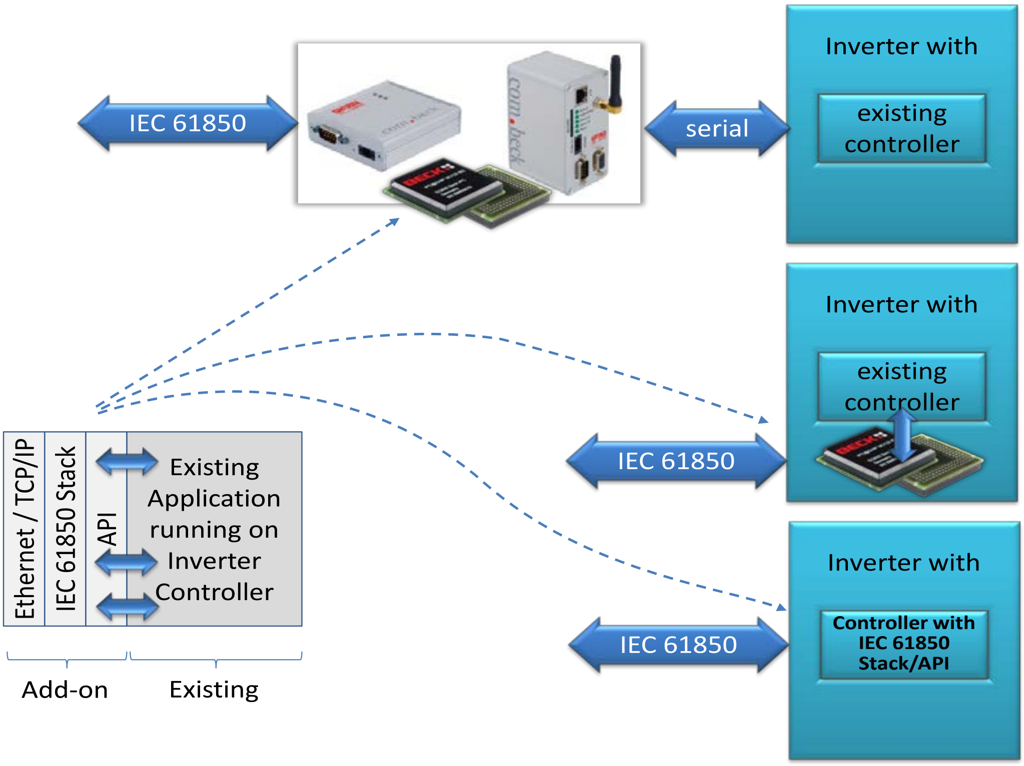
Example Settings

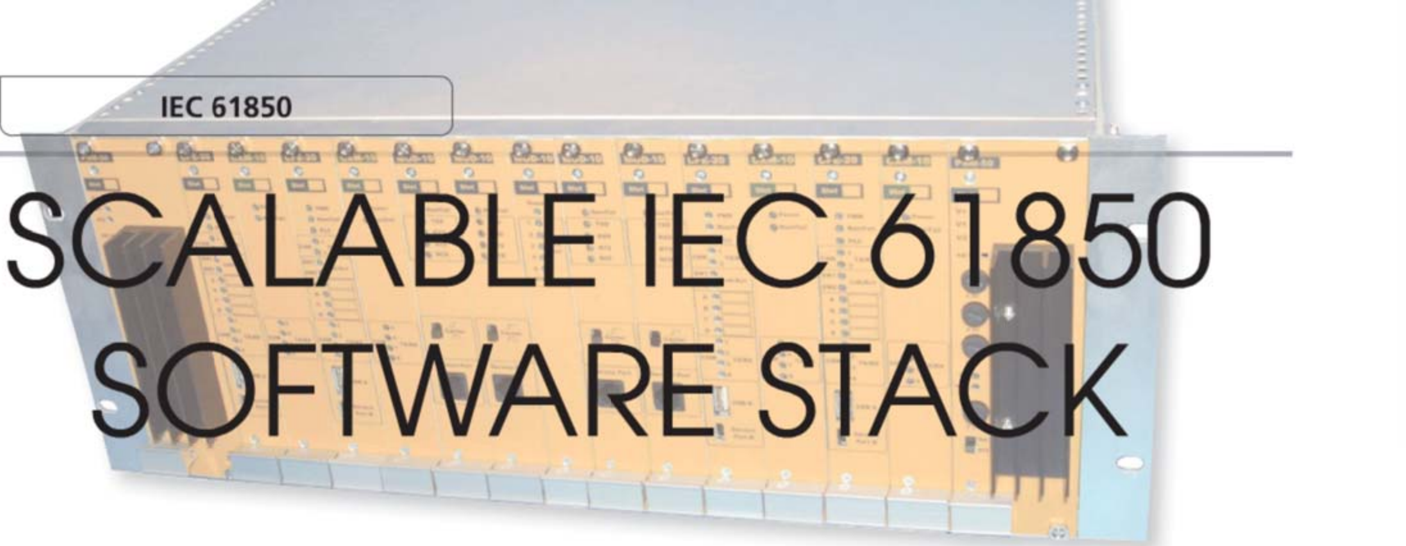
Voltage Array (% VRef)		VAr Array (% VArAval)	
V1	97	Q1	50
V2	99	Q2	0
V3	101	Q3	0
V4	103	Q4	-50

VAr Ramp Rate Limit – fastest allowed decrease in VAR output in response to either power or voltage changes	50 [%VArAval/second]
VAr Ramp Rate Limit – fastest allowed increase in VAR output in response to either power or voltage changes	50 [%VArAval/second]
The time of the PT1 in seconds (time to accomplish a change of 95%).	10 seconds
Randomization Interval – time window over which mode or setting changes are to be made effective	60 seconds



The information needed for this application is defined in corresponding Logical Nodes of IEC 61850-90-7 and IEC 61850-7-4. From an implementation point of view the standard just provides an external view of the inverter internal information and information exchange (**for the inverter functions, e.g., volt-var control**). It could be assumed that the functions are **already implemented in the existing inverter controller**. Possible implementation architectures are:





SCALABLE IEC 61850 SOFTWARE STACK

A new enormously scalable, lively, and affordable IEC 61850 Software Stack is now available for Smart Grid and other application domains. SystemCORP Embedded Technology Pty Ltd offers a Lite solution across various operating systems and hardware platforms. The new stack offers an extremely easy to use API (Application Programming Interface) creating instant results for software programmers.

By Detlef Raddatz, SystemCORP Embedded Technology, Australia and Karlheinz Schwarz, Netted Automation, Germany

IEC 61850 is *THE* most successful International Standard for protection, control, and automation systems in substations. The standard is intended to be used in centralised and distributed power generation as well as in distribution, factory, and process automation domains.

IEC 61850 is more than just a date communication protocol. The standard defines information models, information exchange services for real-time and SCADA applications in substation automation systems, renewable energy generation and power distribution systems. The configuration of systems and devices is standardised using a standardised XML file.

COMMUNICATION STACK

High costs for implementing IEC 61850 is one of the crucial factors for the standard being used in relatively few applications outside substations. This has now changed. SystemCORP Embedded Technology has developed a portable IEC 61850 communication stack suitable for different operating systems including Microsoft Windows™ and LINUX, and applicable for any application domain including protocol gateways for IEC 870-5101/103/104 and DNP3.0.

CONCEPT OF A SIMPLE API

The API provided by the stack is extremely easy to use by application programmers. It hides all details of the underlying protocols like MMS (ISO 9506). The operational API services are Set, Get, and Update. The information model of the device and the binding of the real world information to the model is completely configured by a standardised XML file (ICD file – IED Capability Description) engineered with the tool "ICD Designer". Any standardised or extended model can be created.

The stack with the simple API has been ported to multiple system platforms.

SINGLE CHIP SOLUTION

The stack has been ported onto SoC (System on Chip) processor specific operating systems such as the Beck-IPC@CHIP™. The SC143 SoC is a powerful but also an inexpensive choice for many IEC 61850 real-time applications. The controller provides the complete IEC 61850 (IEC 61400-25) MMS, GOOSE and Sampled Value communication stacks. The stacks and the device data models are configurable by a standard SCL File (IEC 61850-6) uploaded by FTP to the controller. Applications can be developed in C/C++ and IEC 61131-3. The focus shifts from communication (especially MMS) programming to user applications. The development of affordable standard conformant interfaces for distributed energy resources can now be shortened to days or weeks – from months and years.

DEVELOPMENT KIT APPLICATIONS

The fastest way getting started with real-time applications is developing application on the Beck-IPC@CHIP™ using the development kit DK61. The kit comes with all hardware and software components (including all licenses for C/C++ and IEC 61131-3 compiler and IEC 61850 software).

A "Getting started" CD ROM comes with application examples (including source code).

IEC 61850 AND LINUX

When using the IEC 61850 software stack on LINUX systems the target hardware platform and software development tool chain play an important role when porting packet driver software for GOOSE messaging. Currently the stack supports ARM™, Freescale Coldfire™ and X86 based LINUX systems.

MICROSOFT WINDOWS™

A free IEC 61850 evaluation DLL (IEC 61400-25) as a Starter Kit for Client/Server and Publisher/Subscriber is now available. The Kit contains executable software, C source code and .Net Applications (projects) as well as "Getting started manuals". The Protocol Integration Stack (PIS-10) DLL provides the same simple API. Client and server (publisher/subscriber – GOOSE) install on one or different PCs.

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PIS-10 IEC 61850 Product Road Map

The SystemCORP Embedded Technology PIS-10 IEC 61850 Products are accessible by 5 Routes:

1. ***Hardware Specific Application – ARM, Coldfire, Power PCs***
2. ***Linkable IEC 61850 Stack Library using Linux on your Product Platform***
3. ***IEC 61850 DLL on Windows PC***
4. ***IEC 61850 Linux X86 Library – PC platform***
5. ***Beck-IPC SC143 IEC 61850 Single Chip Solution***

With any Route choose the IEC 61850 implementation – "Lite" or "eXtended":

ICE 61850 Server/Client Application "Lite"	OR	ICE 61850 Server/Client Application "eXtended"		
MMS		MMS	GOOSE	Sample Value

Choose Server and/or Client:

- ***Server and Client,***
- ***Server only, or***
- ***Client only***

After choosing the IEC 61850 Route, Lite or eXtended, and Server and/or Client you'll need:

- ***ICD Designer,***
- ***Annual Maintenance Contract (included Free in first year), and***
- ***Training***

The SystemCORP Embedded Technology IEC 61850 PIS-10 Route:

- ☑ API provides simple integration with IEC 61850
- ☑ We maintain the PIS-10 Library
- ☑ Low Development Expenses
- ☑ Per platform license at Low Price
- ☑ Less resources to develop and deploy product
- ☑ Training: API and Online Manual + Personalized On-site Training
- ☑ We Port to your System
- ☑ Low-cost annual maintenance agreement
- ☑ Start developing your IEC 61850 application NOW
- ☑ SystemCORP has own KEMA certified substation control products
- ☑ Highly customizable single-chip solution available at a low cost
- ☑ Downloadable Demo 61850 Tools

The Alternative Route to Your IEC 61850 Embedded Applications:

- ☐ API provides complex integration with IEC 61850
- ☐ You maintain your own software
- ☐ Large Start-up Development Expenses
- ☐ Per product license at High Cost
- ☐ Longer Start-up development time and longer time to market
- ☐ Training: You get a DVD + Manual
- ☐ You Port to your System
- ☐ Expensive product-based annual maintenance contracts
- ☐ Takes months just to start developing your actual IEC 61850 application
- ☐ Only customer certified products
- ☐ Only Protocol Data Gateways with pre-defined communication protocols
- ☐ No demo tools provided

Choose Your Route

BECK
THE POINT OF SYNERGY

Simple components for effective and fast to market solutions

IPC@CHIP®
The heart of applications

Development-Kit
For simple implementations – Ready to Go

com.tom BASIC
Communication gateway

com.tom RADIO
Communication gateway with GSM/GPRS

com.tom GRAPHIC
Communication gateway with graphic display

■ ■ ■

Your IED

Partners for IEC 61850 and IEC 61400-25

Hard-/Software
SystemCORP
- IEC 61850
- IEC 61400-25
- SCL Tool
- Modbus, DNP3
- IEC 60870-5-101/103/104

Hardware
Exor
- HMI & Scada Solutions

Peopleware
NettedAutomation
- Education
- Training
- Consulting

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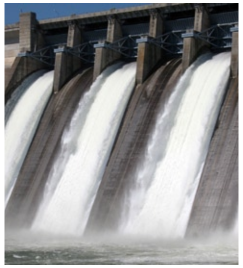


IEC 61850 Lite Implementation

IEC 61850 Client/Subscriber and Server/Publisher Integration on the IPC@CHIP®.

The IPC@CHIP® embedded platform facilitates the quick and cost-effective integration of your information into a standardized format.

Secure Communication

IEC 61850 and IPC@CHIP® for simple to complex applications

Hardware specifikation SC1x3

- CPU SC186-EX / 96 MHz
- RAM (free) 8 MByte (approx. 7 MB)
- Flash memory SC123: 2 MByte (approx. 1 MB)
  SC143: 8 MByte (approx. 7 MB)
- Ethernet 1 x 10/100BaseT / PHY, 1 x MII
- Temp. range -25 to 85°C

IEC 61850 Software implementation

- MMS over TCP/IP
- GOOSE Publisher/Subscriber
- Sampled Values
- Data sets
- Buffered reporting
- Unbuffered reporting
- Control
- Data Logging
- Time synchronization via SNTP
- File Transfer via MMS and FTP

Programming software included

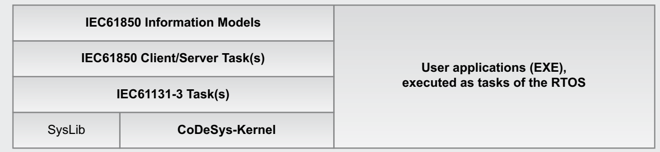
Program your application in C/C++ or IEC 61131-3 and configure the IEC 61850 API with standard SCL (System Configuration Language).

Additional benefits

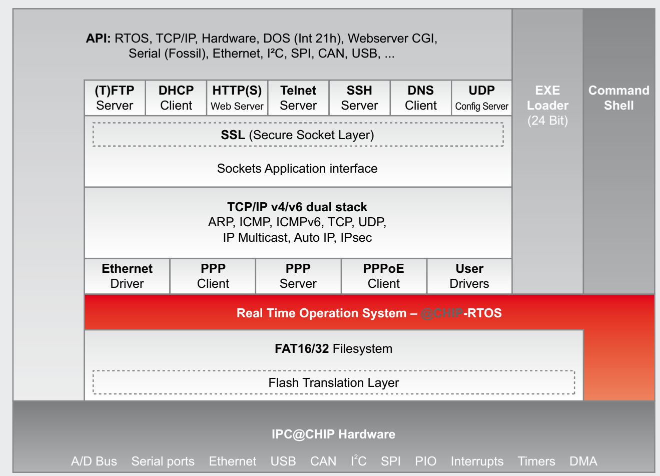
Useful source code sample files are available for free download from **www.beck-ipc.com/examples** :

- CAN
- Industrial communication (Modbus, EasyIP ...)
- etc.

Software implementation



IPC@CHIP® RTOS architecture



SC2x
Flexible, simple and powerful

SC1x3
Maximum functionality in a minimum of space

SC2x3
Maximum performance for demanding automation tasks

Simple extension with Add ons

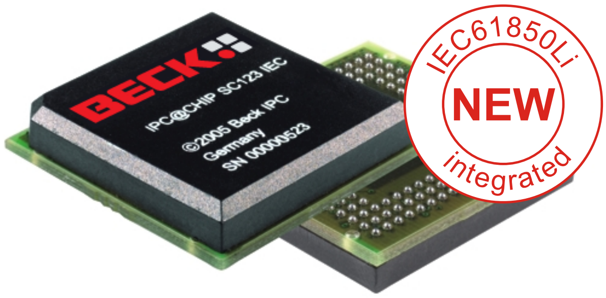
Additional extensions in preparation

- Wireless LAN
- Bluetooth
- GSM/GPRS
- Graphic
- IEC 61131-3 — CoDeSys
- EtherCAT — EtherCAT Technology Group
- M2M Communication
- Fieldbus

Development Kits for all Hardware Platforms

Up and Running in 15 Minutes

Information Sheet: IPC@CHIP® SC123 / SC143



The SC123/SC143 is a further addition to the IPC@CHIP® product series, offering more performance, more memory and more functions whilst still maintaining full software compatibility with existing SC11 and SC13 controllers.

All the critical and well-established hardware functions and interfaces of SC11/SC13 are retained on the SC123/SC143, and have been enhanced with a number of additional key functions.

The new BGA design supports larger unit volumes in all aspects of industrial control and communication.

	SC123	SC143
Design	BGA177, 25x25x5mm	
CPU	SC186-EX / 96 MHz	
RAM (free)	8 MByte (approx. 7 MB)	
Flash memory (free as Flash disk)	2 MByte (approx. 1 MB)	8 MByte (approx. 7 MB)
Ethernet	1 x 10/100BaseT / PHY, 1 x MII	
Serial	4 x TTL	
CAN	2 x CAN 2.0B master / slave, 1 Mbit/s	
Other interfaces	USB1.1, I2C, SPI	
I/O	31 freely prog. PIO pins (GPIO), 3 x IRQ, 2 x external DMA, 2 timer inputs/outputs, 24-bit address bus, 16-bit data bus	
Operating voltage	3.3V	
Heat dissipation	typ. 1 Watt	
Temp. range	-25 to 85 °C	

Software

Like the well-established SC11/SC13, the IPC@CHIP® SC123 and SC143 products are equipped with the IPC@CHIP®-RTOS preinstalled real-time/multi-tasking operating system and downwards compatible API interface, and are therefore software compatible with SC11 and SC13. Existing SC1x applications can be reused after recompiling with the new Paradigm C/C++ compiler contained in the Development Kit.

The following software functions are also integrated in the RTOS of the SC123/SC143:

- IPv6 (in addition to IPv4)
- Security protocol SSL, SSH and IPSec
- PPPoE
- API for CAN controller (CANopen stack available as option)
- API for elementary USB slave and host functions, support for USB storage devices (USB sticks)
- Only one RTOS version with all available functions (incl. PPP and SNMP)

IEC 61131-3 CoDeSys SP runtime system

The runtime system is derived from CoDeSys SP 2.3 and is available as C library, which makes it easy to implement individual adaptations and enhancements. Besides the extended program memory for CoDeSys-projects the runtime system contains as well a CANopen-stack and supports all 4 serial interfaces.

IEC 61850Li (Lite implementation) integrated

IEC 61850 is a standard for utility automation systems including Smart Grids. It provides a comprehensive data models, communication services, and device and system configuration language (SCL). All models for protection, monitoring and automation for substations in transmission and distribution, monitoring of power quality, hydro power plants, wind turbines, decentralized energy resources like photo voltaic, combined heat and power, diesel gensets, or batteries can be implemented and configured by SCL files.

The IEC 61850-compliant PIS-10 software stack can be launched as a client and as a server. Both applications can coexist at the same time on the IPC@CHIP®. The stack supports IEC 61850 services including GOOSE and sampled values.

More information can be obtained from our website at http://www.beck-ipc.com

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Information Sheet: IPC@CHIP® DK61 Development Kit

The Development Kit for the IPC@CHIP® SC123 and SC143 Embedded Controller

The IPC@CHIP® DK61 Development Kit is a complete development system for the new IPC@CHIP® SC123 and SC143 Embedded Controllers.

In addition to the DK60 Development Board it also contains the Paradigm C/C++ Compiler with the IPC@CHIP® RTOS Debugger and many other tools required for creating C applications on the SC123 and SC143 Embedded Controllers.

Despite the powerful hardware features of the Development Board, providing all the interfaces of the SC123 and SC143, commissioning can be carried out easily in a few minutes thanks to the pre-installed RTOS and the supplied “First Steps” guide.

The extensive hardware and software features enable customized applications to be developed quickly and efficiently.

Programming and debugging are carried out via Ethernet as standard, and are also possible via RS232 or USB.

The DK61 contains the CoDeSys IEC61131-3 software development kit for developing custom IEC61131-3 PLC applications on the SC123/SC143.

IEC 61850Li (Lite implementation) integrated

The IEC 61850-compliant PIS-10 software stack can be launched as a client and as a server. Both applications can coexist at the same time on the IPC@CHIP®. The stack supports IEC 61850 services including GOOSE and sampled values.

DK61 Development Kit

The DK61 contains all the hardware and software components required for the fast development of custom applications:

- DK60 Development Board
- Paradigm C/C++ Compiler (Beck IPC edition for IPC@CHIP®), RTOS Remote Debugger and other tools
- CoDeSys IEC61131-3 SDK for SC123/SC143
- IEC 61850 stack (Client/Server, GOOSE) and a configuration Tool based on SCL
- 100-240V / 24V plug-in power supply unit for DK60 (with adapters for international use)
- 2 PC programming cable (RS232 and USB)
- Ethernet patch cable und cross over cable
- SD card
- Practical systainer

DK60 Development Board

The development board provides on a double Eurocard all the functions required for working with the SC123/SC143 Embedded Controllers:

- SC143-IEC Embedded Controller (96 MHz, 8 MB RAM, 8 MB Flash)
- 2 x RS232 (Sub-D socket)
- 2 x RS232/TTL (connector)
- 1 x USB1.1 (can be configured as host or device)
- 2 x CAN 2.0b
- 2 x Ethernet 100Base-T
- MMC/SD and Compact Flash socket
- Extension port for custom hardware expansions
- Directly programmable I/O pins with LED indication
- Power Fail and Reset buttons
- Power supply, 24 VDC input
- Binding of real data to IEC 61850 models by CID file loaded to controller

Read more about the IPC@CHIP® product range at: http://www.beck-ipc.com

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Test Case			KEMA Verdict	Short Test Description	Function is Integrated in PIS-10 Stack	Function in User Application	Comments
Documentation	**G**	**A**					
Doc1	M	A	PASSED			yes	Template can be provided by SET
Doc2	M	A	PASSED	Verify MICS describes the semantics of all non-standard Logical Nodes, Data Objects, Data Attributes and enumerations		yes	Template can be provided by SET
Configuration	**G**	**A**					
Cnf1	M	A	PASSED	Test if the ICD configuration file conforms to the SCL document type definition or schema (IEC 61850-6)		yes	User to create and conform to model
Cnf2	M	A	PASSED	ICD == MMS datamodel		yes	
Cnf3	M	A	PASSED	Change configuration		yes	Use ICD Designer to extract ICD from CID
Cnf4	M	A	PASSED	Check if the server capabilies in the ICD "services" section do match with the IED capabilites		yes	Manually to be added to configuration
Cnf5	M	A	PASSED	For fixed control model verify the ICD correctly initializes the ctlModel values for all controllable objects		yes	User to create and conform to model
Modelling	**G**	**A**					
Mdl1	M	A	PASSED	Verify presence of mandatory objects for each LN		yes	ICD Designer has auto-error checker
Mdl2	M	A	PASSED	Verify presence of conditional presence true objects for each LN		yes	User to define
Mdl3	M	A	PASSED	Verify non-presence of conditional presence false objects.		yes	User to define
Mdl4	M	A	PASSED	SCSM name length and object expansion		yes	**User to define**
Mdl5	M	A	PASSED	SCSM organisation of functional components		yes	User to define
Mdl6	M	A	PASSED	SCSM concerning naming of control blocks and logs		yes	User to define
Mdl7	M	A	PASSED	Verify data type of all objects for each LN.		yes	User to define
Mdl8	M	A	PASSED	Verify data attribute values from the device are in specified range (this is a continuous effort during the whole conformance test)		yes	User to define
Mdl9	M	A	PASSED	Data model extensions should be implemented according to the extension rules in IEC 61850-7-4 Annex A.		yes	User to define
Mdl10	M	A	PASSED	Check if the order of the data attributes within the Data Object types match with IEC 61850-7-3		yes	User to define
Mdl11	M	A	PASSED	Check if the order of the data objects within the Logical Node types match with IEC 61850-7-4		yes	User to define
1: Basic	**G**	**A**					
Ass1	M	A	PASSED	Associate and release a TPAA association	✓ Yes		
Ass2	M	A	PASSED	Associate and client-abort TPAA association	✓ Yes		
Ass3	M	A	PASSED	Associate with maximum number of clients simultaneously	✓ Yes		
AssN2	M	A	PASSED	Incorrect association parameters	✓ Yes		
AssN3	M	A	PASSED	Set up maximum+1 associations, last associate is refused	✓ Yes		
AssN4	M	A	PASSED	Disconnect the communication interface, the DUT should detect link lost within a specified period	✓ Yes		
AssN5	M	A	PASSED	Interrupt and restore the power supply	✓ Yes		
Srv1	M	A	PASSED	GetServerDirectory(LOGICAL-DEVICE)	✓ Yes		
Srv2	M	A	PASSED	GetLogicalDeviceDirectory	✓ Yes		
Srv3	M	A	PASSED	GetLogicalNodeDirectory(DATA)	✓ Yes		
Srv4	M	A	PASSED	GetDataDirectory / GetDataDefinition / GetDataValues	✓ Yes		
Srv5	M	A	PASSED	GetDataValues request with the maximum number of data values	✓ Yes		
Srv6	C	A	PASSED	SetDataValues of writable attributes	✓ Yes		
Srv7	C	A	PASSED	SetDataValues request with the maximum number of data values	✓ Yes		
Srv8	C	A	PASSED	Request GetAllDataValues for each functional constraint	✓ Yes		
SrvN1abcd	M	A	PASSED	a: – GetLogicalDeviceDirectory with wrong parameters b: – GetLogicalNodeDirectory with wrong parameters c: – GetAllDataValues with wrong parameters d: – GetDataValues with wrong parameter	✓ Yes		
SrvN1e	C	A	PASSED	– SetDataValues with wrong parameter	✓ Yes		
SrvN3	C	A	PASSED	SetDataValues with mismatching data type	✓ Yes		
SrvN4	M	A	PASSED	SetDataValues for read-only data values	✓ Yes		
2: Dataset sel	**G**	**A**					
Dset1	M	A	PASSED	GetLogicalNodeDirectory(DATA-SET) followed by GetDataSetValues and GetDataSetDirectory	✓ Yes		
Dset10a	M	A	PASSED	Compare GetDataSetValues with GetDataValues	✓ Yes		
DsetN1ae	M	A	PASSED	a = GetDataSetValues response- e = GetDataSetDirectory response-	✓ Yes		
5: Unbuf.Reporting	**G**	**A**					
Rp1	M	A	PASSED	GetLogicalNodeDirectory(URCB) and GetURCBValues	✓ Yes		
Rp2	M	A	PASSED	Optional fields	✓ Yes		
Rp3	M	A	PASSED	Trigger conditions	✓ Yes		
Rp4	M	A	PASSED	General Interrogation	✓ Yes		
Rp7	M	A	PASSED	Buffering events in one report	✓ Yes		
Rp8	C	A	PASSED	Verify the DUT can send reports with data objects	✓ Yes		
Rp9	C	A	PASSED	Verify the DUT can send reports with data attributes	✓ Yes		
Rp10	M	A	PASSED	Verify that all buffered events shall be sent before integrity reports can be sent (IEC 61850-7-2 clause 14.2.3.2.3.3)	✓ Yes		
RpN1	M	A	PASSED	GetURCBValues with wrong parameters	✓ Yes		
RpN2	M	A	PASSED	No triggerconditions	✓ Yes		
RpN3	M	A	PASSED	IntPd=0	✓ Yes		
RpN4	M	A	PASSED	Configure URCB when enabled	✓ Yes		
RpN5	C	A	PASSED	Exclusive use of URCB	✓ Yes		
RpN6	C	A	PASSED	Configure unsupported URCB options	✓ Yes		
6: Buf.Reporting	**G**	**A**					
Br1	M	A	PASSED	GetLogicalNodeDirectory(BRCB) and GetBRCBValues	✓ Yes		
Br2	M	A	PASSED	Optional fields	✓ Yes		
Br3	M	A	PASSED	Trigger conditions	✓ Yes		
Br4	M	A	PASSED	General Interrogation	✓ Yes		
Br7	M	A	PASSED	Buffering events	✓ Yes		
Br8	M	A	PASSED	Buffering reports on lost association, buffer overflow	✓ Yes		
Br9	M	A	PASSED	Set EntryID	✓ Yes		
Br10	C	A	PASSED	Verify the DUT can send reports with data objects	✓ Yes		
Br11	C	A	PASSED	Verify the DUT can send reports with data attributes	✓ Yes		
Br12	M	A	PASSED	Verify that all buffered events shall be sent before integrity reports can be sent (IEC 61850-7-2 clause 14.2.3.2.3.3)	✓ Yes		
BrN1	M	A	PASSED	GetURCBValues with wrong parameters	✓ Yes		
BrN2	M	A	PASSED	No triggerconditions	✓ Yes		
BrN3	M	A	PASSED	IntPd=0	✓ Yes		
BrN4	M	A	PASSED	Configure BRCB when enabled	✓ Yes		
BrN5	M	A	PASSED	Exclusive use of BRCB	✓ Yes		
BrN6	C	A	PASSED	Configure unsupported BRCB options	✓ Yes		
9ab: GOOSE	**G**	**A**					
Gop1	C	A	PASSED	GetGoCBValues	✓ Yes		
Gop2	M	A	PASSED	GOOSE slow retransmit	✓ Yes		
Gop3	M	A	PASSED	Initial GOOSE stNUm=1, sqNum=1	✓ Yes		
Gop4	M	A	PASSED	GOOSE datachange - fast retransmit	✓ Yes		
Gop5	C	A	PASSED	Test mode / Test flag	✓ Yes		
Gop6	C	A	PASSED	Disable a GoCB	✓ Yes		
Gop7	M	A	PASSED	ConfRev not changed after restart	✓ Yes		
Gop10	C	A	PASSED	GOOSE with data objects (attributes are mandatory?)	✓ Yes		
GopN1	C	A	PASSED	When GoEna=TRUE, no attributes of the GoCB control block can be set except for GoEna	✓ Yes		

Test Case			KEMA Verdict	Short Test Description	Function is Integrated in PIS-10 Stack	Function in User Application	Comments
9b: GOOSE Subscribe	**G**	**A**					
Gos1	M	A	PASSED	Send single GOOSE message with new data	✓Yes		
Gos2	M	A	PASSED	Test or NdsCom is set	✓Yes		
Gos3	M	A	PASSED	sqNum rollover	✓Yes		
GosN1	M	A	PASSED	Missing GOOSE	✓Yes		
GosN2	M	A	PASSED	Double GOOSE	✓Yes		
GosN3	M	A	PASSED	Delayed	✓Yes		
GosN4	M	A	PASSED	Out-of-order	✓Yes		
GosN5	M	A	PASSED	No GOOSE	✓Yes		
GosN6	M	A	PASSED	Invalid GOOSE	✓Yes		
12a: DOns	**G**	**A**					
Ctl2	C	A	PASSED	Test flag	✓Yes		
CtlN3	M	A	PASSED	Operate value is the same as the actual value	✓Yes		Current position of switch to be provided by user application, depends on hardware design
CtlN8	M	A	PASSED	Operate a direct control object twice from 2 clients		yes	User implementation according to hardware design
CtlN11	C	A	PASSED	Status remote - controls are accepted; Status local - controls are rejected		yes	User implementation according to hardware design
DOns1	M	A	PASSED	Correct Operate request		yes	User implementation according to hardware design
DOns3	M	A	PASSED	Client requests Oper resulting in Test not ok	✓Yes		
12b: SBOns	**G**	**A**					
Ctl2	C	A	PASSED		✓Yes		
Ctl3	M	A	PASSED		✓Yes		User application to interact with stack internal control state machine according to hardware design via API
CtlN1	M	A	PASSED		✓Yes		
CtlN2	M	A	PASSED		✓Yes		
CtlN3	M	A	PASSED		✓Yes		User application to interact with stack internal control state machine according to hardware design via API
CtlN4	M	A	PASSED			yes	User implementation according to hardware design
CtlN11	C	A	PASSED	Status remote - controls are accepted; Status local - controls are rejected		yes	User implementation according to hardware design
SBOns2	M	A	PASSED		✓Yes		sboTimeout needs to be defined in the model and it should have a timeout value
12c: DOes	**G**	**A**					
Ctl2	C	A	PASSED	Test flag	✓Yes		
CtlN3	M	A	PASSED	Operate value is the same as the actual value	✓Yes		User configuration according according to functionality, executed by stack
CtlN8	M	A	PASSED	Operate a direct control object twice from 2 clients		yes	User implementation according to hardware design
CtlN11	C	A	PASSED	Status remote - controls are accepted; Status local - controls are rejected		yes	User implementation according to hardware design
DOes2	M	A	PASSED	Client requests Oper resulting in Test not ok	✓Yes		
DOes5	M	A	PASSED	Send a correct Operate request: 1) with value change, 2) no value change, 3) intermediate value change	✓Yes		User configuration according according to functionality, executed by stack
12d: SBOes	**G**	**A**					
Ctl2	C	A	PASSED	Test flag	✓Yes		
Ctl3	M	A	PASSED	Select all SBO control objects and cancel them in opposite order		yes	User implementation according to hardware design
CtlN1	M	A	PASSED	Operate (without select) a SBO control object	✓Yes		
CtlN2	M	A	PASSED	Select twice, second select should fail (or resets the select timeout)	✓Yes		
CtlN3	M	A	PASSED	Operate value is the same as the actual value		yes	User implementation according to hardware design
CtlN4	M	A	PASSED	Select the same control object from 2 different clients		yes	User implementation according to hardware design
CtlN9	M	A	PASSED	Operate with different value then the SelectWithValue	✓Yes		
CtlN11	C	A	PASSED	Status remote - controls are accepted; Status local - controls are rejected		yes	User implementation according to hardware design
SBOes1	M	A	PASSED	Incorrect Select	✓Yes		
SBOes2	M	A	PASSED	SelectWithValue then 1) cancel, 2) timeout, 3) operate test not ok	✓Yes		User configuration according according to functionality, executed by stack
SBOes3	M	A	PASSED	SelectWithValue - correct Operate request: 1) with value change, 2) no value change, 3) intermediate value change	✓Yes		User configuration according according to functionality, executed by stack
13: Time Sync	**G**	**A**					
Tm1	M	A	PASSED	Verify the DUT supports the SCSM time synchronisation	✓Yes		Time synchronization to be linked with time management of system firmware
Tm2	M	A	PASSED	Check report/logging timestamp accuracy matches the documented timestamp quality of the server	✓Yes		
TmN1	M	A	PASSED	Verify that when time synchronisation communication lost is detected after a specified period	✓Yes		

M: Mandotary
A: Applicable
C: Conditional
n/a: Not Applicable

IEC 61850 Certificate Level A[1]

International Usersgroup

No. 74100344-NMEA 11-0597

Issued to:
SystemCORP Embedded Technology Pty Ltd
Suite 4/12 Brodie Hall Drive
Technology Park
Bentley WA 6102
Australia

For the product:
WebCAN Substation Control and
Monitoring System PIS-10
Firmware V1.36.00

Software runs on the Beck IPC SC143

Issued by: KEMA

The product has not shown to be non-conforming to:

IEC 61850-6, 7-1, 7-2, 7-3, 7-4 and 8-1

Communication networks and systems in substations

The conformance test has been performed according to IEC 61850-10 with product's protocol, model and technical issue implementation conformance statements: "IEC 61850 SET Protocol Implementation Conformance Statement (PICS) WebCAN, version 4.01", "IEC 61850 SET Model Implementation Conformance Statement (MICS) WebCAN, version 1.02", "IEC 61850 SET TISSUES Implementation Conformance Statement (TICS) WebCAN, version 1.02" and product's extra information for testing: "IEC 61850 SET Protocol implementation eXtra Information for testing (PIXIT) WebCAN, version 1.05".

The following IEC 61850 conformance blocks have been tested with a positive result (number of relevant and executed test cases / total number of test cases as defined in the UCA International Users Group Device Test procedures v2.2):

1	Basic Exchange (19/24)	12a	Direct Control (6/11)
2	Data Sets (3/6)	12b	SBO Control (8/14)
5	Unbuffered Reporting (14/18)	12c	Enhanced Direct Control (6/13)
6	Buffered Reporting (16/20)	12d	Enhanced SBO Control (11/19)
9a	GOOSE Publish (9/12)	13	Time Synchronization (3/4)
9b	GOOSE Subscribe (9/10)		

This Certificate includes a summary of the test results as carried out at KEMA in the Netherlands with UniCAsim 61850 version 3.21.02 with test suite 3.21.02 and UniCA 61850 analyzer 4.22.02. The test is based on the UCA International Users Group Device Test Procedures version 2.2. This document has been issued for information purposes only, and the original paper copy of the KEMA report: No. 74100344-NMEA 11-0596 will prevail.

The test has been carried out on one single specimen of the product as referred above and submitted to KEMA by SystemCORP. The manufacturer's production process has not been assessed. This Certificate does not imply that KEMA has certified or approved any product other than the specimen tested.

Arnhem, 15 Maart 2011

M. Adriaensen
Regional Director Management & Operations Consulting

Robin Massink
Test Engineer

1 Level A - Independent Test lab with certified ISO 9000 or ISO 17025 Quality System

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