Industrial IT Solutions for Advanced Process Control and Optimization

Creating value through integrated solutions

APC products designed for control engineers by control engineers

ABB
As one of the world’s leading suppliers of advanced process control and optimization, ABB has provided you with equipment, systems, software and services to run your operation productively and profitably. You’ve thought of us as a measurement company, a controls company and an automation company. We’re all of those things. And all of those things combined are Information Technology, or IT. We focus IT on the core processes in your industry, blending the needs of the IT world with the needs of Industrial Automation. That’s ABB’s IndustrialIT.

Our experience

ABB has worked in the field of advanced process control (APC) and optimization since the 1980s, working with innovative technologies that range from multivariable predictive control to real-time optimization, from neural networks to statistical process control. Our software tools deliver the most effective and advanced solutions for any process problem.

ABB’s IndustrialIT APC suite brings about major improvements in the performance of your business. Our technology builds upon years of industry experience, state-of-the-art software applications, and a high level of integration within ABB. It draws upon worldwide plant operational design, process engineering and licensing expertise.

ABB’s IndustrialIT Advanced Process Control suite: designed by control engineers for control engineers

ABB’s application engineers have faced and tamed every possible control problem. Working side-by-side with control room operators, they have implemented advanced process control and optimization using applications and products from around the world.

Their practical experience is backed by ABB’s research into control theory, information technology, mathematics and statistics. ABB delivers world-class technology from our own R&D and from our software partners, using best-in-class tools to improve an integrated application package, for a small-scale single-unit plant or a large-scale multi-unit facility.

Our APC and optimization solutions simplify commissioning and maintenance, and then drive your process towards its economical optimum with:

- Increased throughput
- Minimal quality giveaway
- Increased profitability
- Enforcement of safety and environmental operating constraints
- Less energy consumption
- Improved efficiency
- More complete information about the process at every level of your enterprise

Services

ABB has operating units world-wide: nobody else provides such a complete network of skilled engineers for APC and optimization services. What does that mean for you? No more waiting for weeks to adjust your control configurations or for basic trouble-shooting. No more language barriers between your control room crew and APC experts.

Plant Performance Improvement

ABB continues to provide support once plants are operating. With experience in all phases of plant design and operations, we provide our clients with technology updates, training, plant optimization advice, operations trouble-shooting and access to models to enhance plant performance. We share our knowledge and insight so that you can increase the productivity of your assets over their lifecycle.
A complete, integrated solution for your control and optimization problem

An Integrated Solution

ABB is the only provider who builds integrated solutions that enhance your return-on-investment. ABB combines the ability to deliver APC with the systems integration capability to install DCS, safety systems and turnkey analytical solutions. APC can work with traditional analyzers like GCs or with advanced NIR installations.

Our automation systems aren’t tool kits but full-fledged, robust, flexible, “plug and produce” applications. Each system interfaces with the others and integrates with existing and future plant systems. Whether you’re building a new plant or upgrading your current facility, our solutions meet your needs today and grow with your future needs.

ABB’s advanced solutions encompass:

- Multivariable control
- Real-time optimization
- Proprietary process model-based control
- Process modeling
- Dynamic simulation for training and engineering applications
- Neural network models
- SPC and MvSPC

ABB’s advanced application services include:

- Complete installation and commissioning services
- Process control performance auditing
- Plant performance benchmarking
- Process evaluation and development

A Complete Solution

ABB control products and systems offer multi-tasking, multi-language support, graphical operator interfaces, flexible connectivity, fast installation and easy diagnostics and programming. The APC suite is based on a set of common components which give the packages a common look and feel and provide a familiar interface for the engineer or operator.

ABB is providing a set of programs that are designed to work together to provide the end user with a complete solution. They cover the requirements of most on-line advanced control applications that you will encounter in your plant. The heart of most APC applications is the multivariable model predictive control (MPC) algorithm, which we supply as OptimizeIT Predict & Control. To complete the installation, you will need more than MPC.

A typical MPC application includes quality control of process variables only measured in the lab, or measured intermittently by analyzers. To supply this capability, ABB provides the OptimizeIT Inferential Modeling Platform. Not just capable of inferentials, this package provides a platform for all supporting APC calculations. The package provides built-in connectivity and update functions for laboratory data. The user can implement and execute customized advanced applications without any custom programming at the PC or DCS level.

The final piece of the puzzle is long term tracking of the application. The on-line part of the platform includes SPC and MvSPC packages. SPC tracks how well MPC is maintaining product quality. Operators and production engineers monitor the SPC tracking and periodically adjust the quality targets to make more money from the application. If SPC indicates that there is operation beyond a quality control limit, the engineer can adjust the quality target, analyze the overall application performance using the latest MvSPC techniques and address the root cause for the degradation.

Without a complete approach, your APC application will take longer to deploy, will be painful to implement and will not deliver maximum benefits.

Every product we build delivers:

- Reliability in the most demanding applications
- Ease of use and maintenance
- Scalability, expandability and platform independence
- Seamless integration with existing systems
- Up-to-date and accurate information
- Protection of current and future assets

Typical scope of services for an APC or optimization project:

- Project management
- Site survey and analysis of existing facilities
- Master plans and ROI estimate
- Basic and detailed design / prototyping
- Base control fine-tuning
- Operator and engineer training
- Installation and commissioning
- Post-commissioning services and application maintenance
OptimizeIT Predict & Control is a multivariable control package. The package consists of off-line tools to screen and process data, dynamic model identification procedures and controller tuning analysis. The on-line portion of the package consists of a control server that executes the applications configured with the offline tools. Operator interface is provided through a client application.

**A new controller, not just another new product**

OptimizeIT Predict & Control is much more than the latest version of a model predictive control (MPC) algorithm. It’s based on new technology that replaces the typical MPC collection of single-input/single-output (SISO) step response models with a true multiple-input/multiple-output (MIMO) state space model.

ABB’s approach is made possible through a new model identification algorithm that finds accurate state space models from plant test data. The state space model predicts the effect of disturbances with far better accuracy than current technology. Better prediction means better control. OptimizeIT Predict & Control merges a solid control algorithm with vastly superior modeling technology to deliver overall better performance.

The state space model allows OptimizeIT Predict & Control to use a Kalman filter for state estimation as part of the feedback control algorithm. The Kalman filter makes the best estimate of process input and process output disturbances. Where a SISO step response model merely allows estimates of static biases to the process variables, the MIMO state space model allows estimates of the total dynamic effect of process input disturbances.

The state space model also permits the engineer to specify the model structure and to define “extra” or auxiliary process variables that are used to further improve disturbance estimates. A key temperature, for example, can provide advance warning of disturbances to a critical composition.
Maximum use of the Available Information

OptimizeIT Predict & Control is a better controller because it is looking at all the information available so that it can make better decisions. This starts with using state estimation that gleans information about input disturbances from process measurements, and continues with a controller formulation that will follow the operator's objectives. The controller can be configured to use trajectories for setpoint, feedforward and constraint variables. If the desired behavior for a setpoint is a ramp, the controller uses a ramp in the control algorithm objective function. Other controllers try to fool the control algorithm by changing the setpoint a little bit at each execution. These controllers operate with insufficient information to control tightly to the ramp. Feedforward variables can be scheduled with an input trajectory. This is especially useful for cyclic operations such as regeneration of absorbers, back-washing filters or for any other discrete operations with defined start and stop times. Feedforward and setpoint trajectories can work together to execute product grade changes or production rate ramping. Constraints also use trajectories, but this is to ensure smooth, steady, robust behavior while enforcing the process limits.

Complete Flexibility

ABB’s control algorithm is structured to help your plant reach its operating objectives by providing the user with an easy way to directly specify goals. Predict & Control provides multi-objective quadratic optimization with prioritized control objectives and time-domain tuning constants. Multiple levels of constraints are difficult to tune without a multi-objective, sequential optimization algorithm. When degrees of freedom exist in the process at steady-state, the controller can drive to operator entered manipulated variable (MV) targets through a quadratic objective function or to an economic optimum using linear cost coefficients for controlled variables (CVs) and MVs. A user selectable option exists to let engineers tune setpoint, feedback and feedforward objectives independently.

Industrial IT Design = Better Performance

Advantages

State space models represent process behavior more realistically:
- Estimation and representation of disturbances are improved
- Models are more accurate, with better estimation of gains during model building
- True representation of integrating variables, like level, provide greatly improved control performance

Time-based three degrees of freedom tuning gives the user maximum flexibility to match plant operating objectives:
- Time-based tuning is more intuitive for the user
- Setpoint, disturbance and feedforward response times may be specified separately

OptimizeIT Data Manager

The OptimizeIT Data Manager collects, processes, and plots data, which it shares directly with ABB’s powerful OptimizeIT Predict & Control and OptimizeIT Inferential Modeling Platform. The Data Manager provides direct DCS and OPC connections, real time trending, and either exports data to other formats like an Excel spreadsheet or stores data in a local database for future use. The OptimizeIT Data Manager helps process engineers analyze process problems and resolve control system issues; it augments but does not replace traditional historians. Users can quickly define a tag list, set the sampling rate, collect data from the system OPC server, store the data, filter the data, and remove outliers. The Data Manager expedites DCS cutovers and unit startups, captures data that is not collected by the historian, and helps preserve transient information by using a higher sampling rate.
The OptimizeIT Inferential Modeling Platform (IMP) is a software package for off-line development and on-line implementation of empirical models.

Building on existing process data, empirical models infer missing parameters and physical variables and thus estimate process properties that are unmeasured or infrequently measured. The OptimizeIT Inferential Modeling Platform allows development of empirical models featuring different modeling techniques so that neural networks, statistical regressions, and principle component analysis (PCA) are all combined into a single package. On-line monitoring tools like SPC and MvSPC are also available. The platform is made of distinct off-line and on-line software environments.

**IMP Model Builder**

The off-line environment features built-in functions for:

- Data import from different sources
- Data handling (data set merging and splitting, data editing, calculated tags, etc.)
- Data analysis (statistical analysis, principle component analysis, etc.)
- Automatic outlier removal data handling (ABB’s exclusive technology)

Filtered data are then used to build models. Models can be developed using different technologies including neural networks, multiple regressions and scripting for user defined models.

The OptimizeIT Inferential Modeling Platform exploits the power of two of the most well-known and effective data processing and modeling tools available today:

- NeuroShell Predictor® neural technology from Ward Systems Inc.
- Qualstat® for statistical data analysis and statistical modeling from InControl Inc.

When used with ABB proprietary routines, these tools unleash the capabilities of neural networks, data analysis, and modeling technology without requiring specialized knowledge in mathematics or statistics.

Built-in functions provide validation tools for developed models. Models can then be saved and exported to the on-line environment.

**IMP On-line**

The on-line environment provides the deployment platform for developed models, bridging the gap between technology and control room implementation. IMP On-line lets engineers quickly and easily connect models to the basic automation layer through OPC, without writing a line of code or making a single configuration change to the DCS. Model results may be written back to the DCS for monitoring on the operator console or even used for closed-loop optimization. Because of IMP’s open architecture, calculations can be implemented through a scripting language. IMP On-line provides special wrappers that are ideal for exploiting legacy models in any software format.

NeuroShell Predictor is a registered trademark of Ward Systems Inc.
Qualstat is a registered trademark of InControl Inc.
Powerful built-in monitoring functions provide statistical analysis of inferential measurement performance. The inferential properties are periodically and automatically recalibrated through laboratory data. Trend and chart tools are also provided.

**Typical applications for IMP**

- **Inferential Measurements**: Inferential measurements are real-time estimates of product qualities, otherwise available only through periodic laboratory analysis. ABB has applied this technology in a wide range of plants. Examples of quality parameters include ASTM distillation temperatures, flash and cloud points, RVP, octane numbers, and Mooney and viscosity factors. Inferential measurements are built using different modeling techniques. The model provides the relationship between the available process variables and the proprietary to be estimated. Typically, the most efficient modeling techniques in terms of cost-benefit ratio are those that use a data-driven approach, like neural networks.

- **Predictive Emission Monitoring**: EPA regulations require the installation and proper operation of “Best Available Control Technology” (BACT) to minimize the emission of pollutants. This includes monitoring of both instrumentation and parameters. In this scenario, Predictive Emission Monitoring Systems (PEMS) are increasingly used either as an indicator of analyzer performance or as a surrogate for physical equipment. Empirical models are the most effective way to build reliable software analyzers that enhance emission monitoring.

- **Fault Detection and Isolation**: You need to be sure that equipment is working properly and that nothing is affecting its efficiency and safety. IndustrialIT harnesses the information already in place inside your automation system. ABB’s products use this historical data to quickly build models that predict the correct output of the equipment. A comparison, between the predicted and the actual values, provides early detection of problems and triggers an alarm or maintenance action.

- **Multivariate Statistical Process Control**: MvSPC compares process operating conditions with defined baseline data and provides a metric to express the magnitude of the difference. Thanks to powerful Hotelling $T^2$ statistics, it’s easy to track where a process is and where it should be. When something pushes your operation away from the expected region, a click on the $T^2$-plot uncovers the responsible event.

**Advantages**

- A modeling package that is intended for deployment in on-line closed loop applications
- Accommodates process delays in data sets for model building
- A complete set of statistical analysis tools
- Advanced regression capability, multiple linear regression analysis and Principle Components Analysis
- Proprietary, patented, automatic outlier removal technology
- Various modeling techniques, including unique feedforward neural networks and powerful generalized regression neural networks (GRNN)
- Automated building and comparison of multiple model architectures from the same data set
- Off-line “What-if” mode
- Easy re-use of custom or legacy models
- Models easily plug into on-line environment
- Informative, on-line displays available without configuration
- Multiple pre-configured strategies for including laboratory or analyzer updates
- SPC and MvSPC monitoring tools
IndustrialIT solutions from ABB blend the industry’s broadest portfolio of compatible knowledge components with a proven architecture for real-time enterprise automation and information.

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Email: acs.marketing@it.abb.com