

EDSA Micro

The Visual Language of Electrical Engineering

Foreseer Paladin Option



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I. Executive Summary

Paladin is an optional software package added to a Foreseer system. Paladin's key feature is to detect abnormalities in an electrical system. It does this without training and without any user entered alarm points. Paladin is able to detect problems by examining real-time data collected from an electrical system and then comparing this real-time data with a previously developed electrical model of the system. This model is developed using EDSA Technical 2005 software. Deviations of actual values from expected (calculated) values that exceed a 3% deviation trigger an alarm.

By focusing a user's attention towards these deviations, problems can be averted. When problems are averted, uptime and reliability are increased and cost are reduced since maintenance can be scheduled rather than using emergency or possibly overtime labor plus rush shipping of parts after the system has failed.

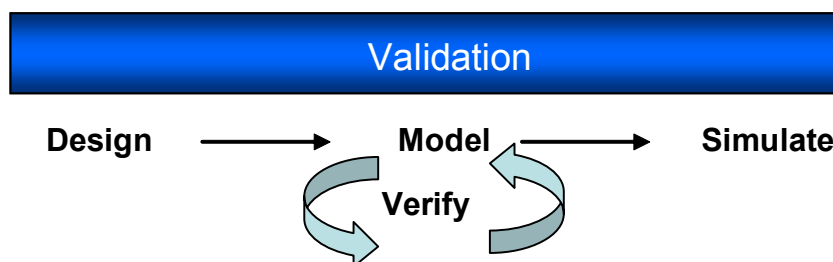
II. How It Works

When a power system is being designed, one of the initial steps is the design of the system. This is typically done using CAD software to define what and where cables, devices, breakers etc. will be placed. With a design application such as EDSA Technical 2005, this design includes the type, size and manufacturer of all the elements that comprise the power system. The database of components and their associated specifications creates a "bill of materials" that is then used to procure the equipment specified in the design.

Knowing where to place cables, breakers etc and what specifications are required is of limited value until you know that your "design" will work for the intended application. Designs range in complexity from simple such as small office buildings to large and/or critical facilities such network operations centers, data centers, semiconductor manufacturing, pharmaceutical manufacturing and hospitals.

Regardless of the complexity of the power system, they all have one thing in common; without power nothing will happen at the finished facility. Electrical power is the most fundamental service required by all facilities.

To know if your design will perform as you expect, you have several options. You can simply build the system and see (or hope) the system will perform as anticipated or you can model the design and simulate the loads to see if your system will perform as expected.



Technical 2005 has many advanced features that translate to the core of the Paladin solution. It is not within the scope of this document to provide detailed analysis of the some of the advanced features, but to provide an introduction. For more detailed descriptions, please refer to EDSA Technical 2005 documentations and tutorials. Some of the current capabilities include:

Advanced Power Flow – This is the heart and soul of Paladin and the Paladin Power Analytics modeling system. Advanced power flow is based on mathematical and scientific techniques that when applied predict or model the power flow (voltage, frequency and power factor in particular) for a given power network. Advanced power flow is the primary precursor to all Paladin Power Analytics. ***Advanced Power Flow is an existing element of Paladin Power Analytics.***

Short Circuit Analysis – Short circuit analysis provides a modeling technique to see how the selected protection devices will respond to various power conditions (e.g., fuses, circuit breakers or motor starting). ***Short Circuit Analysis (protective device evaluation) is an existing element of Paladin Power Analytics.***

Protection Coordination – In conjunction with power flow, and the short circuit analysis, device coordination verifies and suggests the correct settings for protective devices based on the results of the first two analytical techniques. ***Protective Device Coordination is an existing element of Paladin Power Analytics.***

Advanced Transient Stability Analysis – Advanced Transient Stability is one of the most sophisticated analytics in Technical 2005 and provides a method to assess the dynamic behavior of a power system when subjected to various disturbances. Examples include motor starting and sequencing, under frequency, under voltage and critical clearing time for circuit breakers.

Harmonic Analysis – Harmonics impact a power system and its supported devices in a variety of ways. The impact on breakers, relays, equipment failures and the potential for other catastrophic failures have spearheaded research into the impact of harmonics. Even so, the application of harmonics analysis and the associated system level impact has been limited or impossible prior to the combination of analytical device support and Paladin Power Analytics. This is because of the many combinations of load and sources that can be connected to a bus, with each providing a different resonance frequency and each providing a differing amount of harmonic generation or consumption. Certainly with enough effort, a sufficiently exhaustive analysis could have been manually created, but with Technical 2005, the sequencing of load combinations can be automated, greatly speeding the verification of a design. This automatic reconfiguration of the model is a key feature that allows Paladin to adapt its models to the present configuration of the actual power system, and then reconfigure as loads and/or breakers are switched on and off.

Arc-flash Analysis – With the adoption of NEC article 110.16 and the personnel protective equipment from NFPA-70E-2004, Paladin provides the ability to define the types of clothing, proximity and protective devices necessary for personnel to have in order to approach or effect repairs in a fault situation.

These application areas form the basis for the Paladin Power Analytics by integrating and linking the Technical 2005 design tools with the real time data acquisition platform within Foreseer. As the advanced analytics are merged with the real-time environment within Foreseer, more detail and information will be provided. With this combination you now have a basis on which to compare, and detecting deviations from normal becomes easier.

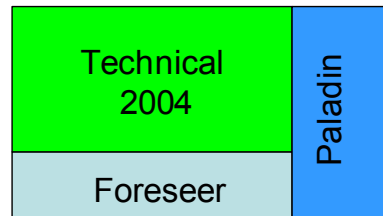
III. Overview

Eaton has introduced the first in a series of business tools to manage power systems providing insight and prediction of potential power problems simply, graphically and intuitively. Paladin Power Analytics will revolutionize how power systems are managed and designed.

To achieve this level of performance, EDSA combines with the Foreseer platform as the primary platform on which Power Analytics operates. Paladin combines three unique products, using each as a key element to the overall solution set. These three components, Technical 2005, Paladin Power Analytics and Foreseer represent the core of a mature, yet unique product offering.

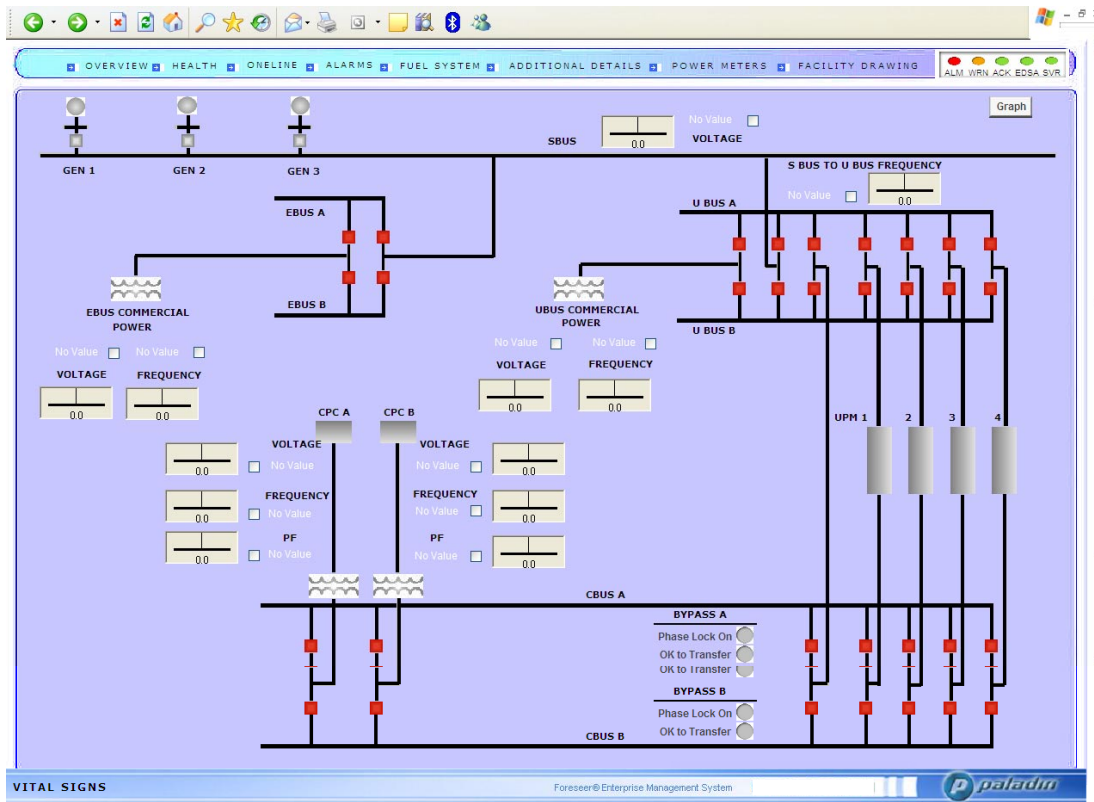
Eaton with EDSA are developing and expanding our capability in Power Analytics to become preeminent in the world of power systems management by bringing previously unavailable engineering solutions to the marketplace.

The EDSA Solution Set



Vital Signs – Paladin provides immediate knowledge of the health of the power system according to the overall design of the system. In much the same way as a Physician or other emergency medical personnel check your vital signs and compares these to your previous normal values, by using this comparison they are able to quickly assess your overall health. When you begin to have medical problems, it is your deviation from vital signs that show the first indication of a problem. With this information in hand, the medical personnel begin looking for causes of the problem based on the type of deviation.

Regardless of how complex the power system, Paladin Power Analytics provides the analogous vital signs for the power system. Alarm management becomes a simple matter of notification based on any change beyond 3% variance with the Paladin model, regardless of the equipment, regardless of the manufacturer, regardless of the configuration. In fact, meaningful and relevant notification is now possible without having to enter any alarm levels or messages, and these vital signs become the most important items to watch (highest priority).



Prioritizing Alarms – One of the most fundamental and difficult strategies of in any complex mission critical system is what “alarms” are most important and how to prevent being inundated with meaningless alarm messages. How does one determine which are the most important or critical? With Paladin Power Analytics, the process of immediately identifying critical alarms and the potential impact of the alarm is almost automatic.

IV. Product Functionality

Paladin Power Analytics is analogous to the business analytics provided by many ERP companies including SAS, Oracle, SAP and others. Paladin Power Analytics represents a breakthrough in real-time power management. Analytical tools that are normally used off-line or as part of a post event (post mortem) are now part of the real-time environment.

Predict - Paladin can predict a problem based on a combination of powerful analytics and a real-time data acquisition system that continuously acquires, learns and compares data from equipment that comprise your power infrastructure. Using this data it learns how your system should be performing. By continuously “adapting,” learning and, in effect, aging with the system, Paladin treats your power system as a system, and not a collection of individual points of failure. Real knowledge, in real time.

Prevent – With the insight gained through Paladin, Paladin can either inform the appropriate personnel of an impending problem, or actually take control of the system depending on your power management philosophy.

Present – Paladin presents information in a clear, concise, executive dashboard rather than thousands of detailed alarms and screens that might confuse, or worse, cause the user to miss the root cause of a problem. Paladin does this through a powerful, secure web browser interface so that all you need is an Internet browser and the authority to view or interact with the information. In fact, the multiple levels of security permit users of varying levels and security to interact only with what is appropriate for their level and nothing more.

Power systems are similar in many respects to network systems. Utility power networks are more like wide area networks (WAN’s) and many of the analytical techniques of utility power networks are similar to WAN network management. Power networks in a facility (such as a data center, network operations center or other related IT type facility or an industrial facility such as an automotive factory or semiconductor manufacturing plant) have issues similar to a local area network. These differences are very important to the techniques applied and the approach to Power Analytics. Most of this document is focused on the facility power management (the LAN analogy) rather than utility power management (the WAN analogy).

V. Key software objectives

- ***Power Vitals - Health***
 - ◆ Manage a complex power system based on variance to the ideal (model)
 - ◆ Identify trends based on the overall health of the power, not specific values
 - ◆ Automate power management strategies based on the system design (regardless of the hardware used)

- **Power System Optimization**
 - ◆ Optimize for low loss of power
 - ◆ Optimize for minimal control settings
 - ◆ Optimize for minimal power generation cost
 - ◆ Find the mathematical balance to optimize on more than one strategy simultaneously.

VI. Product Objectives

Paladin is presented as the leading Power Analytics software system that brings the expertise of advanced engineering analysis to an online, real-time system. Paladin can perform the kind of sophisticated power analysis previously provided only in expensive and time consuming studies every second. Paladin simplifies power management by providing system level indications of health or impending problems to non-power professionals.

From one screen, the user can instantly assess the status or health of their entire power infrastructure using the very design that defined the power system. For the first time, the facility or operation can see if the power network they had designed and installed is performing to the level of original design. This insight, never before available, requires a powerful model of the site constantly and continuously comparing the actual data to the design criteria with exceptions and alarms as the leading indicators (predictions) of a potential failure.

To this powerful platform, EDSA will be adding powerful additions to the real-time environment from our scientific and engineering tools known around the world as the most powerful, comprehensive and capable applications in power system design and analysis.

VII. Configuration

Paladin is offered in six different configurations. These six configurations mirror the standard configuration structure of the various Foreseer Server options based on total channels. For Paladin, the channels are specific to Paladin Power Analytics and not based on traditional Foreseer channels.

VIII. Features

Feature	Benefit
Advanced Power Flow	Verifies that the designed system will meet the designed objective and the resulting model is the primary source of Power Analytics for the base Paladin Systems.
Model Based Management	The most effective, most accurate method for ensuring power systems performance, capability and to identify and predict potential power problems.
Foreseer Enterprise Based Platform	Foreseer provides one of the three critical legs of the overall solution. The performance, connectivity and robustness of Foreseer makes the ideal power management platform and when combined with Paladin Power Analytics provides the most unique and powerful available.

VIII. Product Installation

As mentioned previously, Paladin is installed as an option to any class of Foreseer server (D Class and above). The details of the installation are not relevant to this document but the process involves a standard MSI file that determines if this is a new installation (thereby installing Paladin first) or simply a new Paladin Model (just installing the model).

The installation process creates two new devices folders on the server, one that is the model, and one that is a special folder for channels that are used to write data back to the model (read/write channels), remember that Paladin needs to know what breakers or switches are open or closed so that the predictive model accurately reflects the current power system.

Once installed, the model will largely remain unchanged unless and until the user adds or changes equipment. In the event of a change to the power system, a new model must be created (in Technical 2005, updating the previous model) and loaded into the system. The new model will most certainly require changes to the Webviews that are associated with the changed equipment but those changes are managed through the normal Foreseer upgrade or enhancement processes.

IX. Policies

The Paladin option may only be sold and installed by certified, authorized organizations and is not a user installable option. If a customer desires the training necessary to create and modify their own systems, they must contact Eaton to obtain the necessary training and certification.

X. Limitations

Paladin Power Analytics cannot be installed on the embedded DAE, or on N-Class servers. Paladin Power Analytics can only be installed on servers at release level 4.1 or above and it does require the web server (Webviews) interface. If you have special needs or questions please contact Eaton for additional assistance.

XI. Qs and As

Q. Why Paladin, are their other products that offer similar features?

Power is the lifeblood of the industrial world. Even developing economies depend on reliable power as the primary measure of their development. Monitoring and management systems have developed over the last 20 years to provide effective connectivity, alarming and “robustness” that allows companies and organizations to better manage infrastructure, production, networks and more.

Business analytics evolved as a series of tools that greatly simplified understanding key performance indicators of an organization. In much the same way, Paladin Power Analytics demystifies sophisticated power systems.

Model-based simulations and predictions have long been the preferred as the exclusive method to understand a complex system. From commercial aircraft design and development to hurricane forecasting, the use of sophisticated models to predict the behavior of complex systems is universally accepted as the best way to understand a system.

The problem occurs when the cost of creating a model exceeds the cost of either over-designing the system (to provide some “slack”) or simply taking the “fix when broken” approach to management. The problem of model creation is further complicated when each instance or location requires a unique model to obtain value from the simulation. Consequently, all but the most extreme situations have economic structures that limited the justification of developing a model. Previously model creation was limited to research institutions and high-risk environments such as nuclear power plants. EDSA has developed a way to bring these sophisticated tools to the broader marketplace and to provide management using a simple method for understanding a complex system. The result is Paladin Power Analytics – vital statistics for your power system.

Q. How is the product supported?

Paladin is supported directly by Eaton and by EDSA Micro, and through our strategic partners. Support is provided 7x24x365 via the Eaton and EDSA web sites.

Q. How would you compare the Paladin solution to other options?

There are no immediate competitors to EDSA Paladin Power Analytics.

Q. How do we really predict power problems?

The process has three critical and essential steps:

- 1. You must have a current and accurate survey of the site or confidence in the Technical 2005 design as accurate and,*
- 2. Real-time sensory data located at identified critical points in the power network that correspond to the Paladin Power Analytics model and*
- 3. Initial start-up and verification correctly.*

After these steps are completed, the system then provides instant notification of any deviation between the predicted model and the real-time data. The Paladin “Vital Signs” are the early warning indicators of a potential problem and identify where in the power network the problem is occurring. The alarm indication highlights the area of the power network that the problem is occurring.

In addition to these items EDSA is developing advanced analytics and reasoning that will dramatically extend our Power Analytics. As these new applications become available Eaton and EDSA will provide additional details.

Q. Many customers have asked for waveform display capability, what does Paladin bring to the solution?

Eaton Corporation in addition to supporting all the Eaton meters, protective relays and trip units that support waveform capture, has developed a full function interface with the Nexus meter developed by Electro Industries. This meter is also sold by Eaton and General Electric. With the Nexus design as the reference design, Eaton is developing the interface to the Dranetz-BMI product and has completed the device interface for the Square D and PML products. Foreseer is the only platform on the market able to interface to all the leading PQ meters.

Q. How would a Foreseer customer be able to get the Square D or PML VI interfaces??

Eaton provides device drivers to any customer who purchases the Paladin Option for Foreseer.

Q. How does General Atomics fit into the overall solution?

General Atomics is a leading organization that has a broad range of products and services. Most people know GA is the developer and manufacturer of the Predator unmanned vehicle used extensively in Iraq and Afghanistan. GA is also operates the only fusion nuclear power facility in the United States under contract for the Department of Energy. GA is specifically developing opportunities where they have a strong presence including the US Navy and other allies of the US.

GA is also developing new applications for Paladin and when they are available they will be offered as options to Paladin.

Q. EDSA is a small company, what makes them power experts?

Backed by Eaton Corporation’s extensive power system analysis, diagnostic, predictive and remediation experts, EDSA is recognized around the world for having pioneered advanced power applications and in particular for the EDSA Technical 2005 power systems design and analysis software. Eaton and EDSA have on staff some of the worlds most respected power experts and is often called on by leading government agencies (such as the FAA, Department of Energy and others) to advise or consult in complex or critical power systems. These experts are also available to provide assistance or recommendations for power applications.

Q. If someone is already a Foreseer user, how does the Paladin option work?

The Paladin option can be installed on any Foreseer server release 4.1 and later. Paladin operates within Foreseer and appears to Foreseer as a series of channels. The Paladin Power Analytics model predicts outputs based on the EDSA Technical 2005 design, and provides those outputs to user interface in Foreseer just like another installed device. A series of derived channels (referred to as the “difference channels”) constantly evaluate the predicted output from the real output and notify the user whenever the percent difference is greater than 3% (for voltage, frequency and power factor).

Q. What are “Paladin Channels” and how do I estimate the size of the Paladin Power Analytics to offer?

Paladin channels are the number of channels required to support the Paladin Power Analytics Model. For example, at the FAA facility in NY, there are approximately 3,000 channels on the Foreseer server. Of these 3,000 channels, approximately 800 are Paladin Power Channels (primarily voltage, frequency, power factor and breaker status). This would require a Paladin II option (more than 500 channels, but less than 1,000). The FAA facility is primarily a power system and is very mission critical so the focus is power.

Q. Why does Paladin care about breaker status?

Paladin Power Analytics is continuously adjusting to the model based on the current load or configuration. In other words, whenever the power system changes (as happens when a designated breaker opens or closes) the model adjusts immediately to the new configuration. At the FAA, the 800 Paladin Power channels are encapsulated into approximately 25 “health” or vital signs to instantly convey the overall health of the system.

Q. What if I don’t know if I have a design that was done in EDSA Technical 2005, and how much does it cost to have one created?

If a user does not have a design done in EDSA, or if the design is not up to date, Eaton or another authorized and trained EDSA Technical 2005 design firm must be contacted to create a design. In

many cases, previous designs done in competitive systems are an excellent starting point and EDSA Technical 2005 can import CAD designs from most AutoCAD compatible systems. Remember there are thousands of trained professionals and hundreds of design firms with EDSA Technical 2005 expertise. The cost will vary based on the size of the facility and what if any pre-existing CAD files are available.

Q. How do we create a Paladin model?

The model is actually created in Technical 2005 and can be done by any authorized EDSA Technical 2004-5 organization. In general, the model will either be provided or reviewed by EDSA or assigned Eaton personnel. There are many A&E and design firms who have the ability to provide the model, especially those who provided the original design.

Once the model is created, it is installed via an MSI process through the Eaton Software Configuration specialists managed out of the software group in Lafayette, Colorado.

The steps are:

- 1. Technical 2004-5 based designs*
 - Provide the design files to the Software Configuration specialists. They will be responsible for certifying the design through specific Eaton resources. No model can be created and installed that does not follow this procedure.*
 - Once the model is created and verified, the Software Configurations specialists will arrange to send the MSI (Microsoft installer) to the site or to appropriate technician to install.*
- 2. Designs not done using EDSA*
 - If you do not know if the design was done using an EDSA product or if the design was not done using an EDSA product, please contact Eaton or EDSA directly for assistance on how to either develop or convert a previous design to Technical 2005 as a precursor to creating the Paladin Model.*

Q. Is there any special training required for the customer and if so who does that training?

There are no special training requirements other than the standard Foreseer training. The purpose of Paladin is to provide power management for power professionals or for non-power professionals who need answers and information about their power system that is clear, concise and immediate.

Q. How is the Paladin Model installed?

The Paladin model and any changes to the Paladin model are installed via Microsoft Windows Installer (commonly called the MSI). This file and instructions for its use are provided through Eaton Software Configuration Specialists

Q. How do I obtain the EDSA design files to create a Paladin Model, what do I ask for?

EDSA Technical 200x has many advanced features including revision control, and project management functions. In almost all cases, the specific design for a user will be designated as a “job” or more commonly as a “project”. The Project is a collection of files that EDSA Technical 200x manages including the source files required by EDSA Paladin. The size of the files can be very large, so EDSA includes an advanced compression option called “Pack & Ship”. The designer can simply compress the appropriate project file using the “Pack & Ship” option and email the resultant file to the user location or to any other designated location. If you are unsure where to send the file, or if the file is too large to send, you can also save the file to a CD or upload to an FTP site. Please contact Eaton or EDSA for assistance with using “Packing & Ship” or for further questions regarding FTP transfer.

Q. What happens if the site needs to change their hardware? Who makes the changes to the Paladin model?

Eaton can be hired to change the user’s EDSA model. All Paladin systems incorporate a function known as “calibration” so when the facility changes (either new equipment or changes in specifications for existing equipment) the site must be “calibrated”. The calibration process is simple and easy but can only be done by trained professionals. EDSA has trained and certified the technicians at Eaton.

Q. Can you provide an example of how a Paladin Alarm is more significant than a normal alarm?

Yes, for example what would a frequency or power factor alarm mean with and without Paladin on the output side of an UPS?

When a system is originally designed, the design includes all the significant sources and consumers of power and of the entire power infrastructure. This design is taken through a very sophisticated analysis process that confirms the capability of the design, and identifies potential areas or problems. Remember that this is a system level analysis REGARDLESS OF THE MANUFACTURER. The critical information required includes all the specifications of the equipment and infrastructure such as cables, breakers, relays. The analysis produces a theoretical performance that is constantly modified as the power network changes. In other words, the values predicted by the Paladin model, reflect the system design as it changes dynamically. Previously, a change in monitored power data reflected a point-specific change, not necessarily how the entire power system would respond to change. So a deviation between the predicted model and the actual readings of 3% or greater reflects changes in the overall system, and these predictions change instantaneously as the power network changes.

Power Factor is a ratio (sometimes expressed as a percentage, sometimes as a decimal) of apparent power and true power. This difference provides an immediate indication of how well you are “using” power. Assuming that your power system is a mixture of reactive and resistive loads, the effective use of power depends heavily on how the connected devices are impacting the overall performance of the system.