

WHITE PAPER

Data centers

Energy efficiency and management



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1. Introduction

Achieving high efficiency in data centers is a very demanding task. Two of the main challenges are: building a highly efficient data center and obtaining a sufficient degree of information from the measurements to enable the correct actions to be taken.

In 2022, data centers consumed some 3.5 to 4% of the global energy produced and this value is forecast reach 10% by 2030^[1]. In addition, data center market growth at 4.95%

CAGR is estimated between 2021-2027.^[2]

Green and efficient data centers are vital if this growth is to be permitted without the CO_2 emissions increasing to a great extent.

The most important parameters in defining the energy efficiency of a data center are proposed by ASHRAE and The Green Grid in a resource entitled Power Usage Effectiveness (PUE)^[3]. PUE is calculated in the following way:

Data Center PUE

(Power Usage Effectiveness)





According to the study performed by the Uptime Institute ^[4], the PUE levels of data centers have been decreasing over the years.

To cope with this trend, actions must be taken to increase the efficiency of data centers during their operating life.

PUE values



Another very important parameter is the measurement level, which depends on where the measurement devices are located ^[5].

PUE is measured at three levels

Measurement		Total facility energy	IT equipment energy	Measurement interval
Level 1 (L1)	Required	Utility input	UPS output	Monthly
Basic	Recommended	Utility input	UPS output	Weekly
Level 2 (L2)	Required	Utility input	PDU outputs	Daily
Intermediate	Recommended	Utility input UPS input/output Mechanical inputs	PDU outputs	Hourly
Level 3 (L3) Advanced	Required	Utility input	IT equipment input	Every 15 minutes
	Recommended	PDU outputs	IT equipment input	Every 15 minutes or less

Location of the measurement equipment



Standard EN 50600-2-2 for data centers requires measurement of voltage, current, power, energy and power factor to 1-percent accuracy.

In addition, it recommends measuring total harmonic current distortion and total harmonic voltage distortion (THCD and THVD)^[5].

In view of the above, it will be clear that energy efficiency is not easy to achieve and that having the right measurements is of paramount importance. The requirements include:

- · Measuring devices in the right positions
- High-precision measurement
- Fast and simultaneous data acquisition

Last but not least, the acquired data must be analyzed and represented in the right way. The more accurately these requirements are fulfilled, the more the owner of the data center can be sure that the measured PUE value corresponds to reality.

Even if there were the tiniest variation in the measured PUE value, the data center owner would risk several inconvenient consequences. Here are some examples:

- It would be impossible to measure the energy efficiency of the data center energy correctly,
- It would be difficult to allocate power to the IT loads,
- Planning installation upgrades promptly and effectively would be impossible.

ABB offers a flexible and unique solution that meets all customer measurement requirements while ensuring correct, accurate measurements.

With the right information, it is easy to achieve correct power monitoring, capacity planning and to improve the energy efficiency of a data center.

2. Sustainability in Data Centers

2021-2027 CAGR 4.95%



The need for sustainable data centers is becoming really important owing to the unprecedented increase in data. Society demands the computation of a vast amount of information, which grows every year. This growth consequently leads to the expansion of data centers. According to recent researches and statistics, such as Arizton's global data center market forecast^[2], this trend does not appear to be stopping. On the contrary, it is actually more likely to continue increasing in an exponential way.

Sustainability embraces different aspects of a data center, including:

- economic aspects: demands for less usage of resources
- environmental aspects: the need for less environmental impact
- technical aspects: implying growing usage of long lasting systems

Many studies underline that the right approach is to have a holistic view. Resources cannot be considered independently because they are strictly connected. For example, an increase in productivity requires less energy consumption, less heat dissipation and less space occupancy, as well as less hardware, which has impact on environment. The first step is to understand the sustainability level of the data center, for which a set of measurements is required. As indicated in the Uptime ^[4] survey, most data center operators collect power data for energy efficiency purposes with the aim of reducing operating costs while as yet, few data center operators collect data that can be used for calculating carbon emissions.

Another important issue championed by many governments is water consumption, even when the data center is not located in a place subjected to drought. As the trend is towards a continuous increase in power density hardware, cooling systems will have to become more efficient since there are already 15MW data centers where water consumption equals that of 3 medium-size hospitals^[6]. While air-cooling systems have reached their limit, water-cooling systems offer better heat transportation as well as better quality heat for heat reuse, which improves the sustainability of the data center.

Another important issue to monitor concerns the creation of waste, since most of the components of a data center become rapidly outdated and must be replaced if that data center is to continue to function efficiently. Microsoft stated in 2020 that the average life-cycle of the components used in data centers was about 5 years. Two techniques could be applied to improve this issue: designing long-lasting systems and implementation of a circular economy with increased recycling of materials. Sustainability studies should also involve the supply chain because sometimes, the pollution generated during data center operation could be negligible compared to the pollution generated by suppliers during the production of components. It is therefore clear that the selection of suppliers is of fundamental importance if the sustainability of data centers is to be increased.



Most operators don't track and report key environmental data

Which IT or data center metrics do you compile and report for corporate sustainability purposes?



* Scope 1 and 2 carbon emissions (direct and supply energy) ** Scope 1, 2 and 3 (including emissions from supply chain partners)



ABB sustainability



ABB EcoSolutions

ABB is the right partner for sustainable data centers and can support data center tenants in many ways.

- ABB provides solutions compliant with ISO 50001 for monitoring all the parameters required for sustainability assessment, such as energy and water consumption, estimation of CO₂ emissions, etc.
- ABB provides components designed for long life. For example, ABB protection devices can be upgraded over time. This means that the electrical distribution system will continue to be enriched by new functionalities for increased efficiency of the installation.
- ABB invests in sustainability and works towards the implementation of sustainable practices across the whole value chain and life cycle of products and solutions.

ABB applies Life cycle assessment to ascertain the environmental impact associated with all stages of the life cycle of a product:

- 1. Manufacture
- 2. Distribution
- 3. Installation

Criteria for ABB EcoSolutions™ label



Product must comply with minimum of 4 selected KPIs one from each dimension

4. Usage 5. End of life

ABB products are packaged in recyclable materials to promote the reduction of waste sent to landfills. e.g. wood and cardboard.

The environmental product declaration is available for all ABB products, including product carbon footprints and a section dedicated to end-of-life, thereby contributing to credits for sustainability protocols such as LEED.

Moreover to support our customers' circularity pathways, we have created a new product label, ABB EcoSolutions, which provides full transparency on the circularity value and environmental impact of our products. ABB EcoSolutions products comply with a minimum set of key performance indicators defined in ABB's circularity framework and carry either an environmental product declaration (ISO 14025) or an independently verified product lifecycle assessment (ISO 14040).

3. Energy efficient Data Centers with ABB

Highly efficient ABB devices ensure the highest efficiency for power distribution, including transformers, UPS systems, cables, and protection and switching devices. Thanks to 97.4% UPS efficiency, highly efficient power supply products and the right power supply design, the usual **20% power distribution losses can be cut to just 5%**.

In addition, ABB offers measurement, monitoring and control solutions for further efficiency increases.

Protection devices with embedded metering are capable of measuring and controlling all electrical parameters on all distribution levels, with high flexibility and class 1 accuracy according to standard IEC 61557-12. Having embedded functionalities provides the following advantages:

- No need for additional relays and measurement devices, thus simplicity and time saving
- High level flexibility thanks to seven embedded communication protocols
- · Simple and effective cloud connectivity
- Increased reliability thanks to fewer devices and connections
- Rapid design, installation and integration.

The most important information from the devices can be easily viewed and monitored via ABB Ability™ Energy Manager, which provides simplicity and flexibility. Now available as a local or cloudbased solution.

ABB has tailored solutions for any PUE level defined by the data center standards, enabling data centers to be managed correctly and overall energy efficiency to be increased to a further extent.

Intelligent distribution offering for data centers

ABB components are modular, thus it is easy to create scalable solutions for intelligent distribution in data centers.

To support customers, ABB has already pre-defined offering bundles. Customers can choose from among Essential, Enhanced, and Advanced packages, depending on their preferences and the type of data center.

Offering levels will be differentiated according to monitored load types, devices, and their measuring and communication capabilities. Local or cloud interface systems for monitoring and control will be described separately and will be left as optional at each offering level.

- The Essential offering | Provides metering for Incoming and IT loads. The ability to monitor PUE is provided with this solution. It could be the perfect choice for small installations like the private server rooms of industrial plants. This creates awareness about the energy efficiency status of the data center.
- The Enhanced offering | Enables metering and power quality monitoring of usage by zone. It provides a broader view of power consumption and power quality issues for a larger number of measuring points. This helps to attain energy efficiency goals and optimize maintenance.
- The Advanced offering | Provides complete monitoring and control functions. It consists of a complete package for metering consumptions and ready-made infrastructure for remote control with redundancy in communication. This helps to maximize energy efficiency with up to capillary monitoring.

Since Modbus TCP is one of the most advanced communication protocols, it is recommended as a priority in communication options. It provides better communication performance and is simpler, open and interoperable with the different vendors' devices thanks to use of a standard Ethernet basis. Its client-server architecture enables it to communicate with multiple supervisory systems at the same time. The other communication options will be mentioned in page 20.

ABB pre-designed packages provide lots of advantages:

- Project design time reduced by up to 80%. The package is already defined and can be easily customized if necessary.
- Reduced project risk as digital connectivity is tested by ABB
- Scalability. Thanks to their modular design, ABB components ensure adaptability to different projects
- Upgradability. All packages can be upgraded at any time without the need to change hardware, but by adding advanced functionalities available from the ABB marketplace. This can result in up to 70% reduction in maintenance costs for upgrading the electrical system.

The table below contains an outline of all the available pre-defined packages for intelligent distribution in data centers.





Communication with SACE Emax 2 air circuit breakers



Ekip G

3.1. The Essential data center monitoring solution

To obtain the basic level of measurements, which is the minimum required for assessing PUE, the main incoming breakers and downstream breakers of UPSes equipped with measuring capabilities can be used without any additional measuring device. This reduces the number of components in the system and simplifies the wiring. Emax 2 and Tmax XT circuit breakers, which must be chosen according to electrical characteristic requirements, should be equipped as indicated in Table 1. This enables the breakers to measure current, voltage, frequency, power, energy, power factor and peak factor with the precision indicated below and to connect, via the Modbus TCP protocol, to any monitoring system. Thanks to special trip unit Ekip G Touch, the circuit breakers can provide special protections for generators such as Loss of excitation (ANSI 40) or Active overpower protection (ANSI 32OF). In addition to the protections provided by generator suppliers, this enables redundancy, thus a more reliable system.

Although this solution is simple and has a low initial cost, very little information about the energy consumption of the data center is available since only two measurement points are installed. Consequently, there is little room for improving the overall efficiency and reliability of the data center.

Current (RMS)	1%	Frequency	0.2%	Power factor	2%
Earth fault current (RMS)	2%	Active power	2%	Active energy	2%
Phase-phase voltage (RMS)	0.5%	Reactive power	2%	Reactive energy	2%
Phase-neutral voltage (RMS)	0.5%	Apparent power	2%	Apparent energy	2%

Table 1. Essential level

Product family	ABB product	Trip Unit	Measuring	Communication	Accessories
Air Circuit Breaker	Emax 2 - E1.2E6.2	Ekip Touch	Measuring Packag	e Ekip Com Modbus TCP	Ekip Supply
Air Circuit Breaker	Emax 2 - E1.2E6.2	Ekip G Touch ⁽¹⁾	Available	Ekip Com Modbus TCP	Ekip Supply
Moulded Case Circuit Breaker	Tmax XT - XT7/ XT7M	Ekip Touch Measuring (1)	Available	Ekip Com Modbus TCP	Ekip Supply
Moulded Case Circuit Breaker	Tmax XT - XT2, XT4, XT5	Ekip Touch Measuring	Available	Ekip Com Modbus TCP INT ⁽²⁾	-
Moulded Case Circuit Breaker	Tmax XT - XT2, XT4, XT5, XT7/XT7M	Ekip Touch	-	-	-

(1) Ekip G-Touch and Ekip Touch Measuring already include the Measuring Package.

(2) At this offering level and since there is no need for any other cartridge modules, Ekip Com Modbus TCP for XT2, XT4, XT5 frames has been chosen as the internal version. This internal module is mounted inside the breaker and needs an external 24 VDC supply.



The Essential data center monitoring solution



Network Analyzer

3.2. The Enhanced data center monitoring solution

To get a clear picture of the overall operations performed by a data center and obtain the right basis for starting to improve its energy efficiency and reliability to a further extent, the right number and level of measuring devices must be applied.

This task becomes easy thanks to the broad range of ABB devices capable of recording measurements, monitoring and communication. The devices communicate with each other as well as with any external device, thereby providing the data center operator with unique information.

Measurements are taken and communication is performed by almost all protection devices, transfer switches, UPSes and miniature circuit breakers for issues relating to incoming supplies, IT loads, and mechanical loads.

Load



The Enhanced data center monitoring solution

Circuit breakers are equipped with Ekip Hi-Touch trip units for the purpose of acquiring more measurements with higher precision, as described below and in compliance with standard IEC 61557-12. They also have comprehensive data for root-cause analysis and maintenance, providing full diagnostics of the system and guaranteeing complete control of the plant status. Thanks to Ekip G Hi-Touch, the circuit breakers can provide advanced protections for generators such as Rate of change of frequency (ROCOF – ANSI 81R) or Reactive overpower (ANSI OF). In addition, the embedded Network Analyzer package of Ekip Hi-Touch trip units can enable users to detect power quality issues and set controls on the voltage for analyzing the operation of the system: an alarm is generated whenever a control parameter exceeds a preset threshold. This function complies with IEC 61000-4-30 and IEEE 1250.

All the following parameters are continuously monitored:

- Hourly average voltage value
- Short voltage interruption
- Short voltage spikes
- Slow voltage sags and swells
- Voltage unbalance
- Harmonic analysis.

Current (RMS)	0.5%	Frequency	0.1%	Power factor	2%
Earth fault current (RMS)	2%	Active power	1%	Active energy	1%
Phase-phase voltage (RMS)	0.5%	Reactive power	2%	Reactive energy	2%
Phase-neutral voltage (RMS)	0.5%	Apparent power	1%	Apparent energy	1%

Table 2. Enhanced level

Product family	ABB product	Trip Unit	Measurin	gCommunication	Accessories
Air Circuit Breaker	Emax 2 - E1.2E6.2	Ekip Hi-Touch ⁽¹⁾	Available	Ekip Com Modbus TCP	Ekip Supply
Air Circuit Breaker	Emax 2 - E1.2E6.2	Ekip G Hi-Touch	Available	Ekip Com Modbus TCP	Ekip Supply
Moulded Case Circuit Breaker	Tmax XT - XT7/ XT7M	Ekip Hi-Touch	Available	Ekip Com Modbus TCP	Ekip Supply
Moulded Case Circuit Breaker	Tmax XT - XT2, XT4, XT5	Ekip Hi-Touch	Available	Ekip Com Modbus TCP	Ekip Supply Ekip Cartridge 4 slots ⁽²⁾
Moulded Case Circuit Breaker	Tmax XT - XT2, XT4, XT5, XT7/XT7M	Ekip Touch	-	-	-
Miniature Circuit Breaker	S200, S300, S800, S400 ⁽³⁾	SCU100 Control Unit	Current Sensors	InSite Flat Cable	Connector Set
Transfer Switch	TruONE	Level 4	Available	Ekip Com Modbus TCP	OXEA1 Power Supply
UPS ⁽⁴⁾	-	-	Available	ABB ANC Network Card	-

(1) Ekip Hi-Touch trip units already include measuring, network quality and class 1 packages.

(2) At this offering level, the external communication modules have been chosen so that additional cartridge modules can be added if needed in the future.

(3) The S400 miniature circuit breaker series for the SMISSLINE TP line provides a unique protection solution that ensures the highest possible reliability levels for remote power panels (RPP) and IT loads. The S200 and S800 series are typically used in the Tap-off Boxes of Busway systems. For detailed information on how to select the right circuit breakers and measurement system for RPP sub-distribution applications, please consult <u>configurator website</u>.

(4) UPS types can be chosen according to size, modularity requirements, tier level and data center design.

Another very important advantage is that IT loads can be easily monitored up to the capillary through System pro M compact® InSite devices (comprising an SCU100 control unit and sensors) retrofitted to remote power panels (RPP), and Busway solutions. They measure current, voltage, power factor, THVD, THCD,, energy and power with an accuracy of 1-2%. The current sensors can be easily fitted into the RPP in any location up to 160A so as to measure the power consumption of each server rack. This is an important measurement that provides a precise picture of the PUE level as well as the status of each cabinet.

UPSes guarantee power supply to IT loads, critical loads and the cooling system, which are vital for a data center. Great attention should be paid to them since they are the most frequently serviced parts of the site and the most frequent cause of power distribution failure. Through communication, current, voltage, power, temperature and the battery charge status can be monitored in real time, as can all the alarms and events. This continuous monitoring of UPS parameters helps to prevent damage to servers and other electronic equipment susceptible to voltage and frequency anomalies. In addition, battery status monitoring can enable failures to be detected.

The TruONE® automatic transfer switch with level 4 controller is capable of measuring currents, voltages, active, reactive and apparent power, energy, THVD and THCD. It is also equipped with temperature sensors on the load side terminals, which are used for indicating a possible loose contact with the switch terminal and cable/bar connection. If there is a loose contact on the source side connections, the temperature rise will eventually lead to the load side measuring point as well, so TruONE can also detect these sorts of faults and enable action to be taken before it is too late. 24/7/365 continuous monitoring is certainly much better than thermal imaging performed once a year.

Checking whether the load is connected to Source 1 or Source 2 is possible, as is monitoring the following data in real time: how many times TruONE has been operated, as well as the source statistics, including how long the load has been supplied by the sources and how long the sources have been available. What is highly important is the Last Generator Start, so that information like when the generator was started the last time and how long this took is known at all times and remotely. It is not at all unrealistic for generators not to be tested periodically and thanks to this information, the facility manager knows if this is the case. Thus, the generator starting time provides gives very valuable data if the generator equipment is not working properly since, if the starting time begins to increase during the lifetime of the installation, the situation can be monitored, detected and action can be taken if reauired.

Lastly, TruONE always knows what the conditions were when the generator was operated and can calculate contact wear and estimate the expected lifetime of the device.

Although data centers are built for the highest energy efficiency, this value can decrease over the years (PUE increases) due to aging of both equipment and facility, as well as non-optimal operation. The correct action should be taken to avoid this and cope with the decreasing PUE value trend.

Yearly data center PUE value without actions taken





Reliability

3.3. The Advanced data center monitoring solution

A much more advanced monitoring system can also be obtained with capillary metering architecture, not limited to IT loads alone, but also including other types of loads in the installation. This advanced solution can be applied to any type of data center, regardless of its size.

Anyhow it is easy to understand how capillary monitoring is more important how larger the data center is. Because for large and complex data centers it is important the possibility to reduce costs without compromising energy efficiency and reliability of the installation. In addition, at this offering level, redundancy in communication for critical circuit breakers is required to supply a greater flow of reliable data without requiring any extra space. Another important feature is that the critical products are ready for remote control. After the products have been equipped as indicated in the table below, this connection also enables circuit breakers and transfer switches to be controlled through the Modbus TCP communication protocol. In addition, miniature circuit breakers can also be controlled thanks to the I/O modules of System pro M compact[®] InSite.

Product family	ABB product	Trip Unit	Measuring	Communication	Accessories
Air Circuit Breaker	Emax 2 - E1.2E6.2	Ekip Hi-Touch ⁽¹⁾	Available	Ekip Com Modbus TCP Ekip Com R Modbus TCP	Ekip Supply Ekip Com Actuator M, YO, YC ⁽²⁾
Air Circuit Breaker	Emax 2 - E1.2E6.2	Ekip G Hi-Touch	Available	Ekip Com Modbus TCP Ekip Com R Modbus TCP	Ekip Supply Ekip Com Actuator M, YO, YC
Moulded Case Circuit Breaker	Tmax XT - XT7M	Ekip Hi-Touch	Available	Ekip Com Modbus TCP Ekip Com R Modbus TCP	Ekip Supply Ekip Com Actuator M, YO, YC
Moulded Case Circuit Breaker	Tmax XT - XT2, XT4, XT5	Ekip Hi-Touch	Available	Ekip Com Modbus TCP Ekip Com R Modbus TCP	Ekip Supply Ekip Cartridge 4 slots MOE-E ⁽³⁾
Miniature Circuit Breaker	S200, S300, S800, S400 ⁽⁴⁾	SCU100 Control Unit	Current Sensors	InSite Flat Cable	Connector Set I/O Modules ⁽⁵⁾
Transfer Switch	TruONE	Level 4	Available	Ekip Com Modbus TCP	OXEA1 Power Supply
UPS ⁽⁶⁾	-	-	Available	ABB ANC Network Card	-

(1) Ekip Hi-Touch trip units already include measuring, network quality and class 1 packages.

(2) M = Spring charging motor, YO = Shunt opening release, YC = Shunt closing release.

(3) MOE-E = Electronic stored energy motor operator.

(4) The S400 miniature circuit breaker series for the SMISSLINE TP line provides a unique protection solution that ensures the highest possible reliability levels for remote power panels (RPP) and IT loads. The S200 and S800 series are typically used in the Tap-off Boxes of Busway systems. For detailed information on how to select the right circuit breakers and measurement system for RPP sub-distribution applications, please consult <u>configurator website</u>.

(5) Not compatible with the S400 miniature circuit breaker series.

(6) UPS types can be chosen according to size, modularity requirements, tier level and data center design.



The Advanced data center monitoring solution

With higher precision, more measurement points and information about the equipment status, devices that consume the most energy can be easily identified and the correct action can be taken. It then becomes easy to make cost-effective changes that improve the overall efficiency of the data center.

In addition, with information about the performance of each device in the data center, it is easy to choose the equipment when updating an existing data center, in true compliance with the concept of modularity.

Yearly data center PUE value with actions taken based on measurements and monitoring





Since measurements are taken from most of the equipment, it becomes very simple to track the energy consumption of any part of the data center. By merely looking at the measurement information, you can see whether some part of the data center is consuming more energy than usual. This enables any equipment that is not functioning properly to be immediately repaired or replaced, thereby retaining high efficiency.

For example, if there is a hotspot in the data center, the cooling equipment responsible for this part will automatically increase its energy consumption to maintain a stable temperature.

The only way to recognize this kind of issue is by measuring the consumption of every cooling device. Thanks to the precision measurement capabilities of all ABB protection devices, from 1 A to 6,300 A, there is no need for special equipment or installations in order to meet the previously mentioned requirements.

Further, all devices continuously perform selfchecks. If a device detects any abnormal conditions, it issues an alarm to ensure continuity of the operation and increase reliability.





Selectivity

Another way to improve the energy efficiency of a data center is to reduce distribution losses.





ABB offers equipment able to decrease power distribution losses down to 5 percent for all types of data centers. In addition, having a large number of measurement devices provides clear insights into the causes of distribution losses, enabling the distribution to be optimized for the purpose of increasing efficiency. Let's consider the example of measuring the losses from UPSes.

A DPA 250 S4 UPS has 97.4% efficiency. This means that the losses are 2.6%. Measuring this value with a low-accuracy device will not provide any useful data. The same UPS high efficiency level is available for different data center sizes. For example, MegaFlex DPA UPS can be relied on for larger data centers.

Accurate information about distribution losses can be obtained thanks to ABB's high-precision devices.

The IT equipment installed in data centers can produce power quality issues causing harmonic distortion in the network. Harmonics will lead to additional losses and reliability problems. This can be overcome by installing suitable filters inside the network. However, the right information about the source and level of the harmonic distortion must be available if the filters are to be correctly selected and located. ABB equipment can take measurements up to the 50th harmonic without additional devices, thereby providing the right information and enabling these improvements to be made. In addition, the same equipment can monitor other aspects of power quality, such as average voltage, voltage spikes or short interruptions, voltage imbalances between phases and other issues, thus increasing energy efficiency and reliability to an additional extent.

ABB devices feature embedded power quality meters and thanks to this, power quality measurements can be taken at any point of the data center power supply distribution network. Some of these measurement points could be:

- The utility entrance, to monitor overall power quality
- The power distribution units (PDUs), to identify which group of IT cabinets is producing the power quality issues.

Power quality problems could be easily prevented in this way.

Mechanical loads can consist of power drives, which can also be the source of harmonics; thus, in order to be sure where the source of the problem lies, it is advisable to locate power quality measurement devices at mechanical level. Finally, power quality can also be measured at other data center levels, thereby providing a clear picture of any power quality issues.

In more complex systems, digitalization can significantly increase resilience and continuity of service. Digitalization applied to electrical distribution systems can actually be used to design logic selectivity. Thanks to intelligent relays integrated into protection devices, a faulty part of the system can be automatically isolated within the shortest possible time, while healthy parts of the data center continue to work.

For a complete example of standardized data center architecture that includes intelligent distribution solutions, take a look at "White paper System plus system (2N) electrical distribution - Data Center Design IEC - 0.5 MW IT load design".



ABB Ability™ Energy Manager



Edge Industrial Local View



Edge Industrial Cloud View

3.4. ABB Ability™ Energy Manager

ABB Ability[™] Energy Manager is a digital solution for monitoring and optimizing your energy consumption and CO2 footprint. It enables you to make faster and better decisions based on data insights. It is a ready-to-use solution based on the Software-as-a-Service business model and features pre-engineered functionalities.

Devices can be connected to the platform so as to share data with products (equipped with Ekip Com Hub) or with ABB Ability[™] Edge Industrial Gateway via Modbus RS-485 and Modbus TCP/IP. If there is already a local monitoring and control system (BMS, Scada, EPMS, etc.) in the data center site, thanks to ABB Ability[™] Edge Industrial Gateway and the Modbus TCP communication protocol, ABB Ability[™] Energy Manager can be used simultaneously for the additional functions it provides.

3.4.1 Local View

These are the key features of the Local View version of ABB Ability™ Edge Industrial Gateway:

- The full database can be kept on the gateway server
- Ease of use with pre-configured device integration and guick commissioning
- Current, voltage, power and energy widgets for the devices/device groups and connected asset list with connection status.
- Energy reports with information in a .csv file about the power, energy, current and voltage of a device or group
- Simplified predictive maintenance

This can be a good initial step for small server rooms where an on-premises solution is a must. Please consult <u>ABB Ability™ Edge Industrial Gate-</u> <u>way Local View brochure</u> for the available functions.

3.4.2 Cloud View

By connecting to the cloud you can unlock data and obtain insights about the energy consumption of the site and health of assets. Key features of the Cloud View version:

- · Access to the data anywhere, anytime
- · Live predictive maintenance curve
- Benefits from the highest security standards and comprehensive services
- Flexible and scalable user and subscription management
- · Alerts and alarms, feedback via email or SMS
- · Scheduled and more detailed reports
- Scalable, from a single site to a multi-facility system and more.

Both digital and analog sensors for measuring environmental parameters (temperature, humidity) and meters for other utility consumptions (water, gas) can be connected via the gateway. This function becomes very important considering the criticality of water consumption in the sustainability plans of a data center.

A data center-specific pre-configured dashboard is also available. Users can view all the information about their data center, such as input and output power, energy trends, peak power and more. It can also be upgraded by specific widgets so as to monitor PUE and its trend thanks to the Data center energy package add-on.

PUE monitoring through Data center energy package add-on





The load grouping feature enables the plant overview to be customized in a fast and flexible manner. For example, all the cooling load protection devices can be grouped together to enable the cooling load consumption values to be viewed while maintaining the visibility of the individual values as well. Using the Power protection insight add-on, the user can also monitor the main UPS parameters, such as real time current/voltage/power, battery status and the UPS status/alarm panel. Continuous monitoring of the UPS parameters thus helps to prevent damage to servers and other electronic equipment susceptible to voltage and frequency anomalies. In addition, keeping a check on the battery status can help to detect failures.

Monitoring of UPS parameters and battery status through our Power protection insight add-on



Load Power Forecasting add-on for learning energy consumption patterns



To improve energy management decisions and achieve energy cost savings, our platform not only supports you with historical data but also with a Load Power Forecasting add-on that

provides an advanced forecasting algorithm capable of learning the energy consumption patterns of a whole plant or defined consumption areas.



ABB Ability™ Asset Manager



Predictive Maintenance

3.4.3 Upgrade to ABB Ability™ Energy and Asset Manager

ABB Ability[™] Asset Manager sets a new benchmark for simplicity and flexibility in asset-performance management. It enables you to view and optimize the behavior of your site equipment anytime, anywhere, thanks to an an intuitive graphic interface, thereby providing greater reliability and availability while minimizing unplanned maintenance. ABB Ability[™] Asset Manager can be ordered separately or in the combined version as ABB Ability[™] Energy and Asset Manager.

Predictive maintenance is very important, especially owing to the critical reliability needs of data centers. Using the Low voltage CB health analysis add-on, maintenance can be planned in efficient way thanks to the field device data analysis feature provided, which delivers granular visibility of your asset behavior in real time. Predictive maintenance is based on information from the devices (environmental conditions, operating conditions, events, the effects of the maintenance performed) and a complex algorithm that runs in the cloud through ABB Ability[™] Energy and Asset Manager. Assuming that the maintenance work takes two hours and that the circuit breakers have a 25-year lifetime, the ACBs would require maintenance each year in the traditional scenario, i.e. without predictive maintenance (25 times during the ACB lifecycle). This number drops to 9 times when the predictive maintenance feature is used. This means that predictive maintenance can save you up to 36% in costs.

In addition, with precise details about the health of each device and regular maintenance, the reliability of the whole plant increases dramatically, thus avoiding the extremely high cost of data center outage, which can amount more than 1 million^[4]. According to the latest report from the Uptime Institute^[4], the PUE levels of data centers are decreasing, but there is also a reduction in overall reliability. The solutions outlined here can only increase the reliability of data centers, overcoming the issues reported in the study.

Predictive maintenance through low voltage CB health analysis add-on



Health prediction







The scope and functions of the monitoring, control and operation infrastructures that are frequently encountered in data centers can be outlined in a simple way, as illustrated below. The devices described in the different offering levels can be connected to all these systems when required through use of the communication system interface documents of each device.

Emax2 - Communication System Interface

Table 4. Available communication protocols for related products



Tmax XT - Communication System Interface



Truone - Communication System Interface



Insite Pro M – Manual with Communication Interface

Communication protocols	Emax2	Tmax XT	TruOne	UPS	InSite Pro M
Modbus RS-485	•	•	•		•
Modbus TCP	•	•	•	٠	•
IEC61850	•	•			
Profibus-DP	•	•	•		
Profinet	•	•	•		
Ethernet / IP	•	•	•		
DeviceNet	•	•	•		
BACnet/IP					
Bluetooth ⁽¹⁾	•	•			
Ekip Link ⁽²⁾	•	•			
SNMP V2 and V3, SMTP				٠	

(1) Bluetooth is available for all Emax 2 and Tmax XT breakers with Touch and Hi-Touch trip units. Other protocols can be obtained by adding Ekip modules.

(2) Ekip Link is ABB's proprietary protocol

4. How to increase the efficiency of an existing Data Center

According to one of the latest data center studies ^[7] the size of the data center renovation market is expected to grow to \$60.91 billion in 2027 at 24.7% CAGR.



Retrofitting

In addition to the previously explained trend towards increased data center efficiency, one of the main drivers for data center renovation is energy efficiency. An efficiency increase can justify high data center service costs, which represent around 15% of the total cost of ownership of data centers (TCO)^[8].

Ekip UP

All the previously explained solutions for increasing the efficiency of data centers are based on the design of a new data center. However, the same solutions are also applicable to existing data centers since the ABB Advanced package enables the existing installation to be upgraded. ABB has a broad portfolio of service solutions which can fit any type of installation by providing high-level flexibility and ensuring time and cost savings thanks to advanced technologies.

There are three main ways in which the existing installation can be adapted to receive the solutions suggested for new installations. A high, medium or light impact on the installation can be achieved, depending on how the existing structure is built and the level of changes the data

center owner is willing to apply. The ABB offering for smart upgrades and updates comprises 3 packages:

- light upgrade
- medium upgrade
- high upgrade

4.1. High Upgrade: retrofitting of protection devices

In the retrofitting solution, the existing protection devices are completely replaced with new devices featuring measurement and connectivity capabilities.





Thanks to ABB's advanced retrofitting solutions, the time required for upgrading the installation is minimal, thus maximizing availability.

With the minimum possible impact on the installation, the data center can be equipped with the latest generation of circuit breakers, which feature the lowest losses, are able to take class 1 accuracy measurements and provide connectivity to both the on-site monitoring system and ABB Ability[™] Energy and Asset Manager. The highest level of data center efficiency is thus ensured.

4.2. Medium upgrade of the installation

The metering and connectivity capabilities of the protection devices can be "unlocked", virtually without impact on the existing installation.

This is done by using the digital unit called Ekip UP⁺. Thanks to open-style current sensors, Ekip UP⁺ provides a plug&play solution for every low voltage system. It can be connected to any protection device regardless of whether it uses an electronic or thermo-magnetic trip unit. Thus, everything previously explained for new installations also becomes applicable to existing ones thanks to connection of Ekip UP⁺ digital units.

Connection of Ekip UP⁺ to the installation not only obtains monitoring functions and connectivity, but also provides the same advanced protection functionalities as the new protection devices.

4.3. Light Upgrade: complete flexibility for new installations

If the installation already has the newest devices with measurement capabilities, it can be adjusted using device cartridge modules.

For example, the data center user can upload measuring and power quality packages and add or change cartridge modules without any impact on the installation.

In addition, the new features of ABB Ability[™] Energy and Asset Manager (e.g. predictive maintenance) can be added at any time by the actual user. This provides the data center user with complete flexibility, since new functionalities can be changed or added whenever required and without impact.

Plug & Play module



Medium upgrade of the installation



5. ABB devices for energy efficiency



Circuit breakers

This section presents an overview of the most important ABB devices for measuring and monitoring inside data centers.

5.1. Emax 2 and Tmax XT circuit breaker families and Ekip UP⁺

ABB Emax 2 and Tmax XT circuit breakers range from 160A to 6300A. As well as offering protection functionalities, they can also be used for measuring and monitoring.



The Ekip Architecture of the full range of circuit breakers unlocks high accuracy measurements, embedded in devices, for all electrical parameters (current; voltage; frequency; active, reactive and apparent power and energy; power factor; peak factor; THVD; THCD) with up to 0.5% accuracy (currents, voltages) or 1% accuracy (power, energy).

This includes Class 1 accuracy for power and energy measurements, according to standard IEC 61557-12.

In addition, the Ekip UP⁺ digital unit is designed to upgrade existing installations so as to provide them with the same capabilities as the Ekip trip units in terms of metering, protection and control.

Thanks to open-style current sensors, Ekip UP⁺ ensures plug&play installation for every low voltage system.

In order to acquire, transfer and monitor the parameters being measured, Emax 2, Tmax XT and Ekip UP⁺ can be equipped with seven different communication protocols.





UPSes



DPA 250 S4



MegaFlex DPA

As previously explained, using the Ekip Com Hub module you can connect to the Internet and obtain all the available information through the ABB Ability[™] Energy Manager software.

Thanks to all these features, Emax 2, Tmax XT and Ekip UP⁺ devices are perfect for any type of data center and are capable of providing all the functionalities that the pertinent standards require.

5.2. DPA UPS product lines for data centers

The ABB DPA UpS product line is designed to serve

the data centers of the future and all the models in the family are built with a focus on energy efficiency, reliability and modularity.

The most recent UPS units – DPA 250 S4 and MegaFlex DPA – feature 97.6% module efficiency and 97.4% system efficiency. This means that your UPS will use about 30 percent less power, thereby reducing energy losses and operational costs. The Xtra VFI feature maximizes efficiency under low loads by dynamically adjusting the number of active modules that your critical IT equipment requires. All DPA models are capable of measuring input voltage, input frequency, battery capacity and autonomy, as well as output voltage, power and current.

Based on these values, the UPS can also send alerts if any of the values are above or below the defined limits.



DPA 250 S4 MegaFlex DPA

All this information is available locally on the DPA display, as well as remotely using the Modbus communication protocol.

Finally, for DPA 250 S4 all those measurements are also available in the cloud through ABB Ability™ Energy Manager.



EcoSolutions Label

The MegaFlex DPA[™] Uninterruptible Power Supply (UPS) has become the first Smart Power product to earn ABB's new EcoSolutions label, reflecting the focus on circularity and sustainability that guides our product development process. To earn an EcoSolution label, a product must first obtain an independently verified Type III ISO:14025 Environmental Product Declaration. It must then meet a minimum of four ABB sustainability targets, one from each of the key stages in its lifecycle. The MegaFlex DPA UPS was designed to close resource loops with a strong 75% recyclability rate and clear end-of-life instructions for the user. The Quartino production facility in Switzerland produces MegaFlex DPA with 'zero waste to landfill' and packaging that uses 80% recycled cardboard. Use of MegaFlex DPA has been highly optimized, providing customers with 97.4% system level efficiency and 15-year extended lifetime, thanks to a modular design and services that prolong its working life. According to calculations, MegaFlex customers can save more than 400 tonnes of CO2 equivalent emissions over the lifetime of the UPS. Our MegaFlex DPA UPS solution combines the highest efficiency ratings available with our commitment to the circular economy.

This not only helps reduce energy losses and operating costs, but also provides a product that uses minimal resources and materials that can be easily recycled.

Learn more at MegaFlex DPA - UPS and power conditioning | ABB

Our circuit breakers and more will will be getting the EcoSolutions label very soon. Updated information is available at EcoSolutions website.

ABB EcoSolutions™ Coming full circle.

Together with customers and partners, ABB is innovating to make circular, increasingly sustainable solutions and operations a reality. ABB's new EcoSolutions label provides full transparency to environmental impact across the entire product lifecycle. <u>go.abb/</u> <u>EcoSolutions</u>





Sub distr control u

System pro M compact®

5.3. System pro M compact® InSite

System pro M compact[®] InSite enables currents up to 160 A to be measured.

It consists of a control unit and sensors allowing all data center distribution lines to be easily monitored. It measures current, voltage, power factor, THVD, THCD, energy and power with an accuracy of 1-2%. The measurement devices can be easily fitted into the electrical circuit in any location where the measurement is to be taken.

The system uses an open-loop Hall-effect sensor or giant magneto resistance (GMR) effect sensor.



Three different devices can be used for these measurements:

ibution nit	Technical feature	Unit	Description
	Supply voltage	[VAC]	80-277 (L1-N, +5%)
Fors	Frequency	[HZ]	50/60
	Power input (L1-N)	[W]	545 depending on number of sensors and I/O modules
	Power input , current transformer, secondary side	[VA]	Current circuit <2 (per phase)
- 0000000	Voltage measurement range	[VAC]	80-277 (L1, L2, L3-N)
	Measurement range, current transformer, secondary side	[A]	nominal: 5
			max: 6
	Harmonic component	[HZ]	up to 2000
	Data rate of Modbus RTU	[BAUD]	RS485 2- wire, 2400115200
	Refresh time		1sec / 30 sec (depending on type of data)
	Data storage and export		Integrated 1-year data storage Automatic CSV data export

Any of these devices can easily be connected via the unique bus to SCU100, which can be installed on the DIN rail. This unit enables data to be stored and transferred through different protocols and/or to the ABB Ability[™] Energy and Asset Manager using the Modbus TCP communication protocol.

Input and Output module	Technical feature	Unit	Input module DM11	Output module DM00	Input and Output module DM10
430 AN 430	Number of digital channels		4 Input	4 Output	2 Input + 2 Output
	Voltage (min-max)		active input: 22-26 VDC	relay output: 5VDC-240VAC	active input: 22-26VDC
New 1 . New 1 . New 1 .					relay output: 5VDC-240VAC
	Current (min-max)		active input 4mA	relay output:	active input: 4mA
				5mA-2.5A	relay output: mA-2.5A
				Max 4.5A (<5sec	Max 4.5A (<5sec)
	Pulse minimum duration	[MS]	5	n/a	5
	Pulse frequency	[Hz]	100	n/a	100
	Cross section of terminals	[MM2]	2.5	2.5	2.5



TruONE ATS



Ekip Signalling 3T



SlimLine XR Gold (XRG)

5.4. TruONE ATS

The new TruONE is the world's first true all-in-one automatic transfer switch, engineered to incorporate switch and controller in one seamless unit. It has a range between 200 A and 1600 A and can provide a variety of measurements.

With level 4 controls, TruONE is capable of measuring currents, voltages, active, reactive and apparent power and energy, THVD and THCD. Similarly to Emax 2, Tmax XT and Ekip UP⁺, TruONE can be equipped with communication modules in order to send data to remote locations and the ABB Ability[™] Energy and Asset Manager.

The available communication protocols are: Modbus RTU, Modbus TCP, PROFIBUS, PROFINET, EtherNet/IP, and DeviceNet.



This information is also available remotely using one of the communication protocols above and/ or through the ABB Ability[™] Energy and Asset Manager computer software.

Possible locations for the temperature measurement sensors include the busbar system, distribution board and transformer; environmental measurements are also provided. For example, the analog input can be used for measuring humidity.



5.6. SlimLine XR Gold (XRG)

SlimLine XR Gold (XRG) switch disconnector fuses with ratings between 63 A and 630 A fulfil ever-increasing demands from the industry for safe energy distribution.

5.5. Ekip 3T signalling measurement module

The Ekip Signalling 3T module allows environmental conditions to be measured and monitored.

The module can be installed directly on the circuit breaker and digital units (in the same way as the communication modules).

This module provides three analog inputs for PT100/PT1000 thermo-resistances and one 4-20mA analog input for external sensors. The information from those sensors provides precise environmental details for predictive maintenance purposes. As with circuit breakers, SlimLine XR Gold (XRG) is capable of monitoring fuse status, voltages, currents, active and reactive power, power factor, energy, temperature, fuse status and switch position. It is equipped with the Modbus RTU communication protocol, which enables it to be easily integrated into monitoring systems and/or ABB Ability™ Energy and Asset Manager.

SlimLine XR Gold (XRG) also offers an integrated motor (as an option) for remote or local operation. The motor operator unit is fully integrated into SlimLine XR Gold (XRG).





M4M



ITS2

5.7. M4M network analyzer

The new M4M network analyzer range provides accurate real-time monitoring of the power quality KPIs to enhance reactivity to events in the electrical system, thereby helping to avoid operational impact and uncoordinated maintenance.

Available in two families, M4M 20 and M4M 30 ensure Class 0.5 accuracy compliant with IEC 61557-12 and IEC 62053-22 standards, and represent the perfect choice for sub-metering inside sub-distribution boards and power quality monitoring in main distribution boards and power centers.

In data centers, M4M allows power quality and power reliability to be fully monitored, easily detecting where harmonics are created and preventing damage to installed equipment.



5.8. EQ meter

ABB EQ meters are high-performance, modular DIN rail-mounted electricity meters that are safe, easy to install and can be integrated into existing and future electrical installations.

They are designed to fulfil any type of sub-metering requirement. MID-approved EQ meters are certified and have verified metering accuracy, which is a critical factor in establishing fairness in cost allocation.

The low rated or base currents of these products ensure high dynamic performance with superior accuracy even at low currents. EQ Meters support broad voltage and temperature ranges.

They can also be equipped with built-in serial communication interfaces for M-Bus or Modbus RTU (RS-485).

The range comprises up to 80A direct and indirect, one- and three-phase meters able to read a wide range of values such as active, reactive and apparent power, current, voltage, frequency, power factor and harmonics.



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5.9. ITS2 intelligent monitoring unit

ITS2 intelligent monitoring unit for switches and fusegear lets you optimize your network simply and safely.

Cloud-based connectivity with ABB Ability[™] Energy Manager or local systems through Modbus RTU and Modbus TCP makes it easier to monitor key electrical parameters such as line and phase voltage, current, power, energy consumption but also temperature of 1 phase which can indicate you a temperature rise in the system, which might predict a fault or a loose connection. In addition to the measurements it is also possible to get the status of the fuse and position of the switch.

It can be integrated to InLineII and SlimLine XRG -80% faster installation compared to using separate metering devices. Also it can be used as a stand alone unit, compatible with OT switch-disconnectors and OS switch fuses.



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