

## SMARTER

# Dawn of the digital distribution transformer

ABB's ABB Ability TXpert is the world's first truly intelligent distribution transformer. TXpert combines ABB's world-class transformer expertise with digital technologies and advanced analytics to give customers actionable insights into transformer and grid health.



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Distribution utilities are dealing with far more complicated power grids than ever before. Unprecedented challenges are posed by a bewildering array of factors: rapid expansion of cities and urban areas; incremental grid upgrades; the addition to the grid of renewable generation sources such as solar and wind; and the inclusion of unique loads such as electric vehicle (EV) charging stations. These changes stress distribution transformers – the vital link between the electrical grid and homes, industries and infrastructure – and can result in premature failures, unplanned outages and less-than-optimal grid operation.



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Uptime, safety and the environment are major concerns for operators of, for example, data centers, oil and gas installations, and industrial plants. To handle these concerns, such enterprises maintain their equipment through condition-based asset management systems. Now, to further improve reliability and to protect themselves from the stresses described above, these operators are interested in integrating their electrical equipment, such as transformers, into these systems.

This interest – and the need for faster decisions, real-time action, and improved reliability of distribution transformers – led ABB to explore how to exploit digital technologies to produce a new distribution transformer that would enable customers to address not just today's challenges but also those of tomorrow.



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## ABB Ability TXpert development

Starting from a blank sheet of paper, an open innovation process was begun in ABB that eventually generated a development roadmap based on market segment needs and trends. This roadmap led ultimately to the launch of the new digital distribution transformer, the TXpert →1-2.

At every step of the TXpert development, design and manufacturing decisions were made with the customer's perspective and expectations regarding engineering, operation, maintenance, etc. firmly in mind.

## Which measurements provide vital information?

Customers expect distribution transformers to last for 25 to 30 years; any new additions to the product line should do so too. The question then arises as to which parameters, if they were measured directly, would provide vital information about the asset and electrical supply quality – and which sensors best measure these parameters. Given the conservative nature of the industry, only sensors designed for, and used in, harsh environments and with excellent field reliability were considered. The sensors finally picked are from mature industries and are expected to last longer than the transformer itself. The sensors chosen are for top oil temperature, ambient temperature, pressure, moisture, hydrogen, voltage and current, plus two measurements for the oil levels.

## Data capture and analysis

Every 10 seconds, 14 sensor values of TXpert key operating parameters are recorded and time-stamped. This data is stored fully encrypted for 20 years in appropriately dimensioned memory. Customers reported that data quantities can be overwhelming over time, so advanced analytics integrated directly into the distribution transformer process much of the raw data to produce insights that allow the customers to take suitable action →3.

The current TXpert release conducts two analytics:

- Consumed life of the distribution transformer, which informs the customer how old the transformer is, based on its specific operating conditions.
- Total harmonic distortion (THD), which indicates the quality of the grid around the distribution transformer.



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These two analytics were released first to address the basic needs of most customers. ABB is developing further analytics to address asset health and grid health. Future advanced and predictive analytics aimed at specific customer segments will be released over time via software upgrades.

This is the first time in the industry that so many key distribution transformer parameters are recorded simultaneously. ABB is capitalizing on this opportunity by developing artificial intelligence models that analyze the available data and predict failures and operational events →3.

#### Connectivity

Almost 80 percent of distribution transformers are not connected to or are even near a communications infrastructure. ABB has included WiFi in TXpert for customers to retrieve data and analytics outputs →4-6. For installations in substations, solar farms, wind farms or wherever communication access points exist, there is a wired Ethernet option to allow customers to use their existing infrastructure. Future expansion of connectivity options such as LTE wireless will appear in future releases. TXpert is not locked to a specific protocol or communication medium, which allows the customer maximum flexibility of



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installation anywhere in their electrical grid. TXpert has a Web service user interface that does not require a software installation on customer computers, thus eliminating any burden on the customer's IT organization.

TXpert outputs can be integrated into several software packages, allowing the customer full flexibility to display or integrate data and analytics outputs in a way with which their personnel are familiar.

Cyber security is a key concern for customers. In addition to the stringent ABB guidelines followed during development, testing and validation, three layers of defense were added to support customers:

- The TXpert built-in WiFi is turned off by default and needs to be enabled by an RFID access card. It turns back off after 10 minutes of inactivity.
- Customer computers need to have a valid security certificate to authenticate communication sessions.
- Stored data is encrypted and customers need a decryption key to be able to read the data.



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— 01 A transformer fitted with TXpert, IEC model, ready to be installed. On top is the communications pod for accessing transformer data and analytics.

— 02 TXpert is available as ANSI and IEC models based on regional standards.

— 03 TXpert collects and analyzes a comprehensive set of transformer data. Where appropriate, front-end analysis processes large amounts of raw data to present the operator with actionable intelligence.

— 04 Engaging TXpert's secure Wi-Fi to access transformer and grid information.

— 05 An operator views data and analytics from TXpert ANSI model to understand how the transformer and grid are operating.

— 06 Typical TXpert display.

#### Ease of installation

The TXpert hardware is self-powered from the transformer, so there is no additional effort needed during installation and energization. TXpert is like a traditional distribution transformer from the installation and energization perspectives so requires no special treatment from customer organizations such as operation, maintenance, health and safety, communications and IT.

#### Customer values

The main focus of TXpert is to support ABB's customer needs by providing vital insights for informed decisions that increase reliability and reduce operating costs.

Each market segment has its own needs, challenges and opportunities. Each customer has their own unique needs.

#### For utilities:

- TXpert reduces maintenance costs by scheduling inspections more intelligently – ie, customers focus on inspection based on data trends rather than measurements with absolute value at specific moments in time. With remote communications enabled, key operational data and analytics output is available in real time.
- Knowledge of transformer age allows more accurate replacement planning and reduces inventory cost by reducing the need to buy stock units.
- Balancing the load based on transformer and grid conditions allows customers to utilize assets better.
- With remote communications, immediate outage notification is possible, thus reducing downtime and possible financial penalties.
- Revenue protection or energy theft is a concern for some utilities. Energy thieves will connect to the grid at the transformer point. Not only does the utility lose revenue but the transformer can become overloaded and possibly fail. With TXpert, revenues running through the transformer can be calculated and compared against billing meters to make sure they match.

#### For renewables:

- With the THD value, customers get an indication of the network quality. Further analytics for overall system efficiency, which is crucial in renewable generation, are planned.
- A voltage-profile analytic is planned where customers would get a specific voltage profile for a particular part of the grid during different seasons and at different times, allowing them to take informed decisions rather than the current practice of assumption and simulation. This can eliminate the need for a voltage regulator and allow better grid optimization.

#### For industry and data centers:

- TXpert reports actual, real-time operating conditions, thus increasing the visibility of uptime and reliability.
- TXpert presents a real asset management and proactive maintenance opportunity based on actual operating conditions where customers can integrate TXpert outputs in their asset management and maintenance programs.

#### For oil and gas:

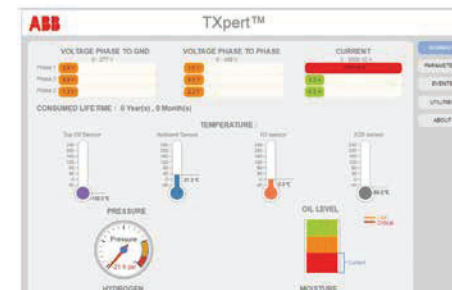
- Knowing key operating parameters in real time and taking appropriate and timely action is of great value for oil and gas customers and the operational safety of the transformer.
- Oil level indication and leak detection help protect the environment.

#### Product launch

ABB launched ABB Ability TXpert in March 2017 and it has been commercially available worldwide since September 2017. The current release covers transformers from 300 kVA to 10 MVA in the 36 kV class. Coming product releases will expand the range of transformer sizes.

Positive customer experiences are already being reported. For example, one customer reported that TXpert showed their transformers were only 30 percent loaded. The assumption had been that the load would be 80 percent, while in actual fact some transformers in the network were overloaded. With the right data and some simple changes, the customer was able to optimize the grid better and make cost savings by right-sizing the transformers.

ABB's deep domain knowledge and expertise are being further enhanced through edge technologies based on ABB Ability, such as TXpert. As TXpert matures, it will be a catalyst for further refining distribution transformer performance, improving predictability and increasing reliability. ●



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