Breaking news

User-friendly products that satisfy new customer requirements and reduce environmental impact

Francesco Viaro

Behind every successful product lies a treasure chest of ideas and creativity, and this is true for ABB's Emax range of low-voltage air circuit breakers. Since their launch onto the market 7 years ago, more than 150,000 of these circuit breakers have been sold and installed in a variety of systems all over the world.

Large companies like ABB know that advances in technology, greater environmental awareness and changing customer demands have an effect on the way customers view old and new products. To keep abreast of these changes, companies must look at upgrading their products if they are to maintain their reputation as innovators and their position as market leaders. Sometimes this can prove more difficult than designing something that is completely new.

When ABB felt it was time to upgrade their Emax range of low voltage circuit breakers, they decided who better to ask for suggestions than the customer. A market analysis revealed that, amongst others, electrical performance and a redesign of the trip unit were areas singled out for improvement.

How does a product family stand out among competing devices with similar or identical functional specifications? The answer is innovation in combination with industrial design. Advances in technology, greater environmental awareness and changing customer demands are, in a way, dictating how innovative companies respond. There is no doubt that many products must be upgraded to meet new customer application needs; to fulfill environmental requirements for lower energy consumption and the use of recyclable materials; and to satisfy an ever increasing request for smaller, cheaper, easy-to-use and endurable products with low maintenance requirements.

These were the challenges that faced ABB engineers when it came to upgrading the Emax range of low voltage air circuit breakers. Improved electrical performance and a redesign of the trip unit featured high on the 'to do' list. A market analysis, identified additional areas for improvement. These were:

- The need for more up-to-date current sensors and consequently the electronic trip unit's input stage.
- The layout of the electronics, which occupies more than one printed circuit board (PCB).
- The need for an advanced HMI.

The analysis also revealed requests for improved current measuring accuracy and a list of new protection functions including:

- Residual current protection.
- A dual set of protection parameters and the chance to switch from one to the other either manually or automatically.
- A dual earth fault protection function.
- A dual short delay protection against short circuit.

There's more

The market research identified even more demands. Customers want a quick and user-friendly way of setting trip parameters – preferably a method that can be instantiated off-line and before installation of the circuit breaker. In addition, they want a better and more complete indication of why a trip occurs, and a data logger function to record all electrical quantities surrounding the tripping event. Accessing this information quickly and from anywhere within a specified location, without the need for physical connections between the trip unit and the PC or PDA was also on the list.

Industrial design criteria

Knowing technically what should be included and how the improvements should be implemented is one thing, making sure they are carried out in an orderly, efficient and logical way is quite another. Therefore, engineers

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1	The new trip unit with accessory modules

applied the group's standard product development model, known as the ABB gate model, to monitor and assess each phase of the upgrade. In addition, they worked in compliance with the ABB design guide, ensuring that the industrial design criteria were taken into account.

Current sensors with a dual purpose

An important element in any circuit-breaker is a current sensor. In low-voltage circuit-breakers, which are fitted with electronic trip units, these sensors are not only used for current measurement, but they must also provide sufficient energy to power the electronics.

Any new type of sensor must therefore be able to carry out these two functions. Because the current transformer is, at present, the best method of transmitting energy to the trip unit, engineers chose a hybrid sensor, comprising a Rogowsky coil, as the basis for the current sensor. This was combined with a current transformer which has been optimized to power the trip unit alone. One advantage of this solution is the linear coil response over the circuit-breaker's entire range of currents. Another important advantage is that because of the optimization of the current transformer, the energy transmitted to the trip unit at high current levels is reduced.

The Rogowsky coil provides a signal proportional to the derivative of the current, and this signal needs to be integrated. This is done digitally with a powerful Digital Signal Processor (DSP), which is part of the overall multi-processor architecture, and essentially the heart of the trip unit. In fact, this DSP has been used to carry out other functions, for example communications, that in previous designs, required separate hardware components.

The elimination of these hardware components combined with a simplified trip unit input stage means that a single PCB is all that is required for the unit's electronics. This is a vast improvement on previous designs where four PCBs were needed to provide the same functionality.

These overall changes have brought about some important results:

- A reduction in the number of sensor sizes, from 24 to 2, for the complete range of circuit-breakers.
- Market requirements related to improved current-reading accuracy and the need for more protection functions have been satisfied.

> In addition to current measurement, any new type of sensor must also be able to provide sufficient energy to power the electronics.

Logical layout of components

Despite its complexity, ABB engineers have managed to arrange the components in a way that ensures the trip unit is more straightforward and user-friendly 1. However, the layout of the display keys heavily influenced the general layout of the device, and engineers were forced to rationalize the position of the electronic components on the PCB.

An advanced and mobile HMI

A combination of ergonomics and modern design criteria has led to the inclusion of an advanced HMI. The choice of a high-definition, low power consuming graphic display means the data are easier to read. And, because of an energy storing capacitor, a description of the alarms can be displayed for up to 48 hours without the need for an auxiliary power supply. Nevertheless, these alarm descriptions are saved and can be viewed long after this 48-hour period has elapsed by simply powering the trip unit.

Applying the ABB design guide, with particular emphasis on shape and form, engineers, using what is known as the 'grid approach', have rationalized and combined HMI design with aesthetic design.

An innovative remote unit was developed to provide an exact replica of the breaker HMI. Connected to the main trip unit via a communication bus, this remote HMI replaces the conventional multimeters without the extra cost of measurement converters. It allows the user to read protection parameters and alarms on circuit-breakers that either have no HMI, or the HMI is in a difficult-to-access location 2.

2 A typical circuit-breaker installation in a switchboard – occasionally uncomfortable for users.

Wireless communication

A wireless link, based on Bluetooth technology[1)], was developed to connect the trip unit to a portable PC, PDA or laptop 3. This enables users to operate in a desktop environment familiar to them. From this environment operators can use electric network dimensioning support programs, eg DOCWin, to ensure optimal adjustment of the protection functions. In addition, users can print reports, save data on different media, or send data by e-mail to other parties from the comfort of their own desk.

In the field, users can connect to and communicate with the trip unit in a user-friendly manner, without the constraints of any wiring. By ensuring they are in the vicinity of the electrical switchboard and up to 10 meters away from the trip unit, the direction and position of the computer is irrelevant, thereby allowing users to comfortably access information or simply view the screen.

The Bluetooth communication driver, developed in cooperation with the ABB Corporate Research in Sweden, enables communications to be established quickly and easily without any direct knowledge of the protocol.

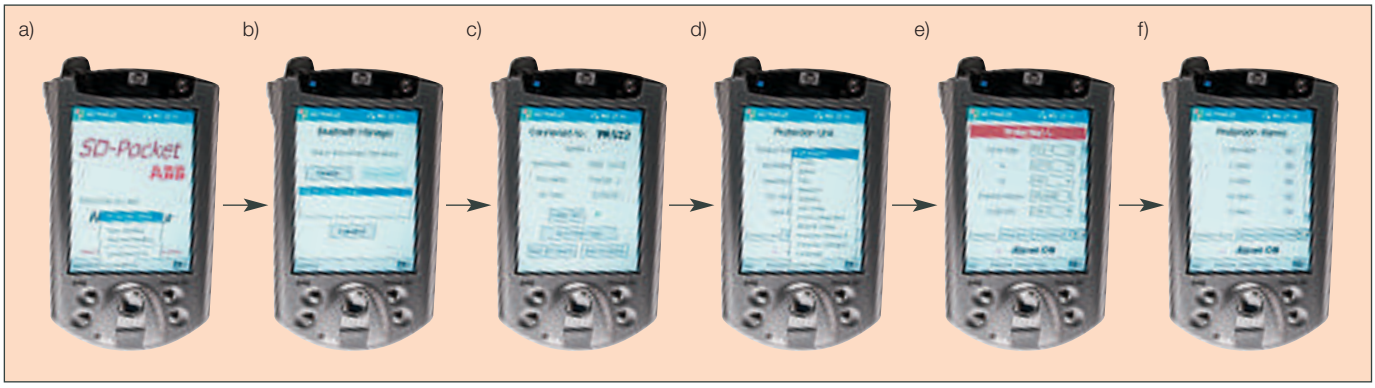
1) Bluetooth is a short-range wireless link open standard, that is easy to connect, and works in the license-free Industrial, Scientific and Medical (ISM) radio frequency band of up to 2.4 GHz.

3 The electronic trip unit is designed for wireless communication

A communication session is initiated by:

- Running the main application (SD-Pocket) 4a.
- A top-level menu appears and the user simply clicks on the menu to interact with a given device 4b.
- The Bluetooth radio is then turned on and a wireless search is performed. A filtered list of all devices detected, ie, those the user is authorized to work on, is shown. Clicking on a given device establishes a connection 4c.
- The main application guides the user through the reading and interpretation of the data as well as through

4 Communication tool running on a PDA for accessing all trip unit information



the adjustment of the trip unit's parameters 4d–f.

Environmentally friendlier enclosures

ABB has always taken environmental issues seriously. As the design team considered ways of improving the housing of the trip unit for easier access and ease-of-use, reducing costs in the process, it, in accordance with the company's environmental policy for sustainable development, was conscious of the need to design for low environmental impact.

> The use of environmentally friendly trip unit enclosures has resulted in a unit that is 70 percent lighter than its predecessor.

The result is a new polycarbonate housing designed to replace the old metal box. This enables the use of a modular trip unit structure with four additional modules that snap into the main housing, thus eliminating the need for screws. Furthermore, the same material has also been used for the 'holders' in the new housing. These holders have two functions: To hold numerous connectors (required to link the trip unit to sensors, and signal and communication systems) and to correctly position and hold the PCBs.

The sum of the above mentioned innovative solutions has resulted in a unit that is 70 percent lighter than its predecessor.

Industrial^{IT} and system architecture

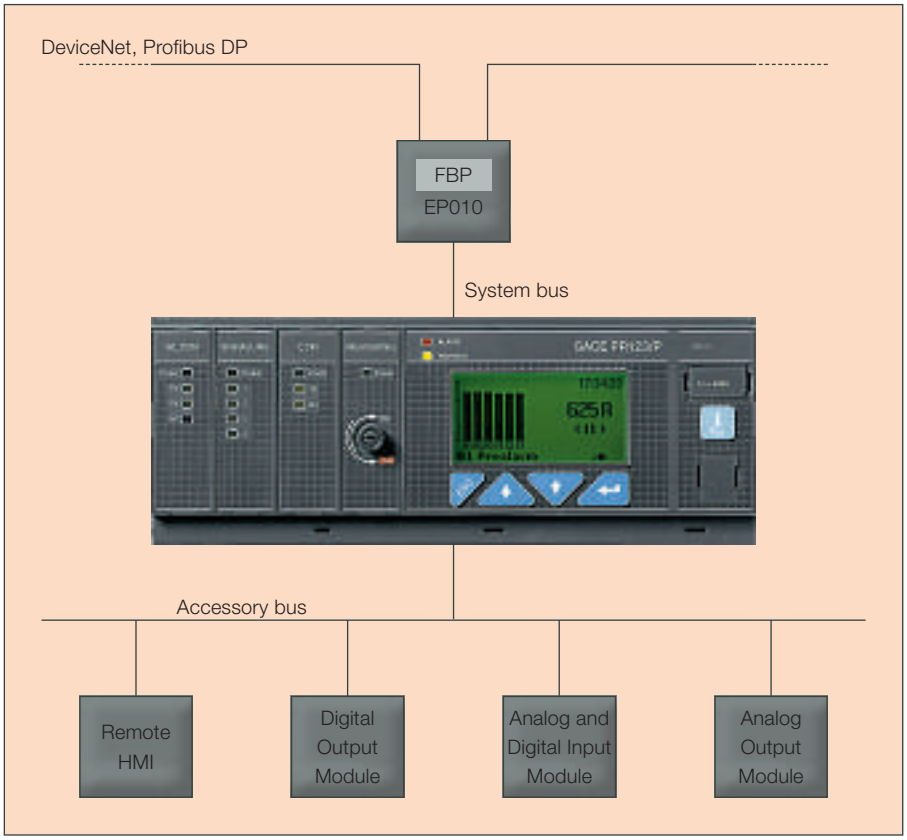
In accordance with ABB's regulations for connectivity certification, the architecture of the new trip unit was designed to communicate with a supervisory system. The final design is illustrated in 5.

The use of fieldbus plug devices allows a choice of fieldbus (eg, DeviceNet or Profibus DP) that best suits the user's specific needs. Compliance with Industrial IT specifications ensures the device will function correctly as part of an ABB system. In addition, an accessory bus makes the trip unit more complete and flexible, allowing it to be used not only with the previously mentioned remote HMI, but also with analogue and digital inputs and outputs. These signals can be processed by the trip unit, thus enabling additional functions, for example:

- The tripping of the circuit-breaker when a digital or analogue quantity threshold set-point has been exceeded.
- The use of conventional measuring instruments associated with the analogue output of any measurements either read or calculated by the trip unit.
- The signaling of any event or alarm generated by the trip unit based on digital outputs.

Using its experience, design guidelines and technology, ABB has come up with an extremely innovative product, which retains the ABB look and feel. This has resulted in a product that maximizes benefits for ABB customers, while at the same time, reduces environmental impact.

5 Trip unit system architecture



Francesco Viaro
ABB Automation Technologies
Bergamo, Italy
francesco.viaro@it.abb.com