Technical Trends of Low Voltage Circuit Breakers and Fuji Electric's Efforts in This Field

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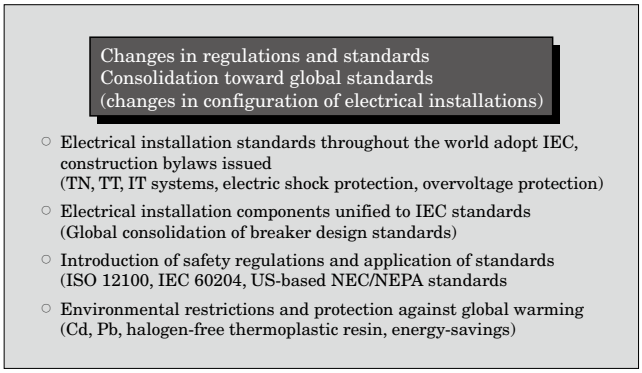
1. Introduction

As countries throughout the world accept the TBT (technical barriers to trade) agreement of the WTO (world trade organization), standards throughout the world for low voltage electrical installations and the components used therein are accelerating toward conformance with international standards (IEC standards and ISO standards). In 1999 in Japan, for example, article 272 "Incorporation of international standards" was added to chapter 7 "Technical standards of electrical installations" of Japanese legal requirement, and equipment that conforms to the IEC standard (IEC 60364 series) has been recognized by Japanese electrical installations. Moreover, standards relating to the electrical installations of industrial machine control gear are also moving toward harmonization with IEC 60204.

At present, as standards for distribution installations and machine control systems are accelerating toward harmonization with the international standards known as IEC standards, many electrical machine systems based on the independent electrical installation standards of an individual country coexist with electrical machine systems based on IEC standards. Based on these circumstances, this paper shall discuss the technical trends of molded case circuit breakers (MCCB) and earth leakage circuit breakers (ELCB), which are the main components used in electrical installations, as well as Fuji Electric's basic philosophy for responding to these circumstances.

Fig.1 Recent changes in low voltage electrical installations



2. Changes in Low Voltage Electrical Installations

Figure 1 shows changes in low voltage electrical installations. As described above, there are two series of electrical installations for each countries, a system unique to the particular country (if there is) and an IEC system. In Japan, the new JIS C 8201, 8210 and 8220 series that harmonize the IEC 60947 and IEC 60898 series standard with the previous JIS standard have been issued as standards for MCCBs and ELCBs. (See Fig. 2.)

Fig.2 Changes in equipment application from the perspective of low voltage circuit breakers (in the case of Japan)

Application categories according to electrical installation standard

New JIS No. system			Construction regulations	
Category	Standard number	Annex	IEC-based construction	Existing construction
Industrial use	JIS C 8201-2-1	Annex 1	○	–
		Annex 2	–	○
	JIS C 8201-2-2	Annex 1	○	–
		Annex 2	–	○
Home use	JIS C 8211	Annex 1	○	–
		Annex 2	–	○
	JIS C 8221 (without OC)	Annex 1	○	–
		Annex 2	–	○
	JIS C 8222 (with OC)	Annex 1	○	–
		Annex 2	–	○

OC : Overcurrent protector

Existing installation regulations

Japanese legal requirement for electrical installation regulations from articles 3 to 271 of the electrical installation technical standards

Mixed use not permitted

IEC-based installation regulations

Electrical installation standard of article 272 of the electrical facility technical standard
Electrical installation standard JIS C 600364 series standard.
Equivalent standards as the IEC 60364 series.

Moreover, for electrical safety, significant changes have been also made in regulations concerning the prevention of faulty touch to live portion and the protection of electric motors.

Meanwhile, to help preventing global warming, with the enactment of the Kyoto Protocol, each country has been responsible for implementing strict mandatory reductions in carbon dioxide (CO_2) emissions. As one way to reduce CO_2 emissions, each country develops its own "guidelines for the rationalization of energy usage" and vigorously promotes the expanded application of those guidelines. At present, electrical energy control is extremely important for commercial buildings and small to medium-size factories.

Consumers are also increasing their requests for an easy-to-construct means for measurement and controll of electric power energy. In response to this request, Fuji Electric is developing a series of energy management components and is also incorporating energy monitoring functions into low voltage circuit breakers, which are the main components used in electrical installations.

3. Changing Need for Low Voltage Circuit Breaker

In response to the changing circumstances surrounding the low voltage electrical installations described in section 2, the main requirements of low voltage circuit breakers are as follows.

(1) Commercialization of a low voltage circuit breaker that supports standards in various countries, in particular, IEC standards and UL standards (See Fig. 3.)
(2) Establishment of a series of circuit breakers equipped with an electric energy measuring function to enable easy monitoring and control of energy savings
(3) Establishment of a series of circuit breakers that ensure high-level safety protection against short-circuits in an electric motor circuit
(4) Development of a low voltage circuit breaker that contains no designated hazardous substances and is capable of helping to protect the global environment

These requirements can be summarized as the "realization of a unified global circuit breaker capable of supporting standards throughout the world." To satisfy such customer needs, a significant change is necessary in the concept of the present series of low voltage circuit breakers.

The basis of Fuji Electric's new concept is to realize the performance required by the IEC standard while maintaining the benefits (compact size, high quality, multiple variations) of a circuit breaker that conforms to the conventional Japanese standards. Fuji Electric's response to realize this need is described below in section 4.

4. Fuji Electric's Response to the Need for Low Voltage Circuit Breakers

Fuji Electric has developed many technologies in advance so as to be able to respond to the need for low voltage circuit breakers.

Examples of this technical development include: ① arc control technology that simultaneously satisfies the interrupting duty of both the UL 489 standard and the IEC standard, ② material technology for molding material and contact material, ③ technical advances concerning the detection of earth leakage current, and ④ structural analysis of a breaker with attached wattmeter.

Fuji Electric then applied the results of this technical development to create ① the "G-Twin Breaker," a single product capable of being used in all electrical installations throughout the world, ② the "Manual Motor Starter" (MMS), a compact-size motor breaker that realizes a new type of electric motor protection, and ③ the "FePSU Breaker," which is optimized for monitoring and controll of energy savings. The main points are summarized below.

Fig.3 Low voltage circuit breakers consolidate to 2 series worldwide

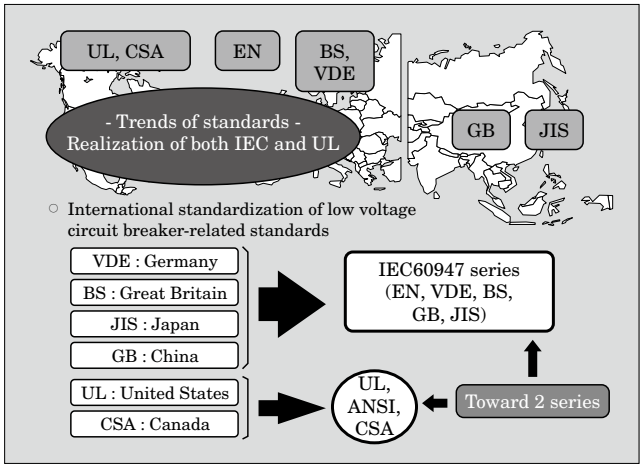


Fig.4 Scheduled internationalization of JIS

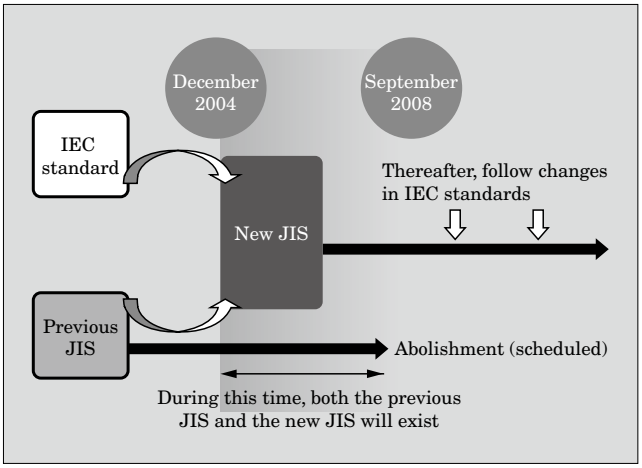


Fig.5 Concept of the new global MCCB and ELCB

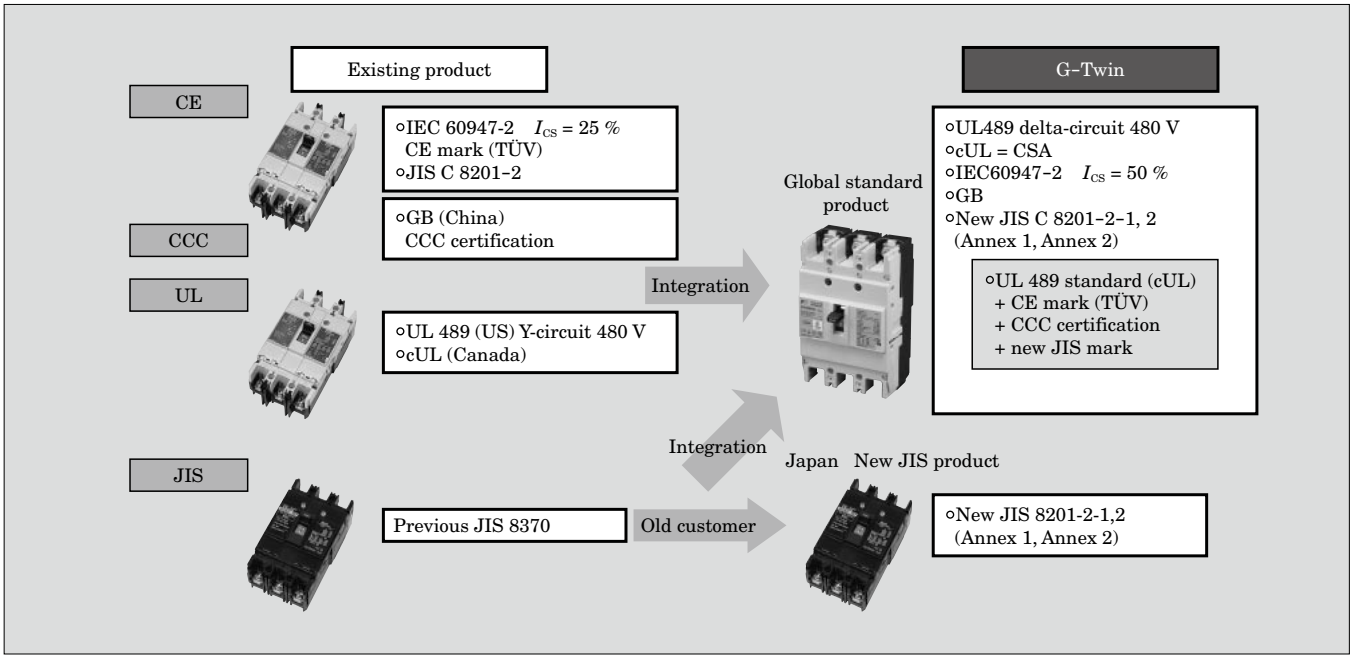


Fig.6 G-Twin low voltage circuit breakers

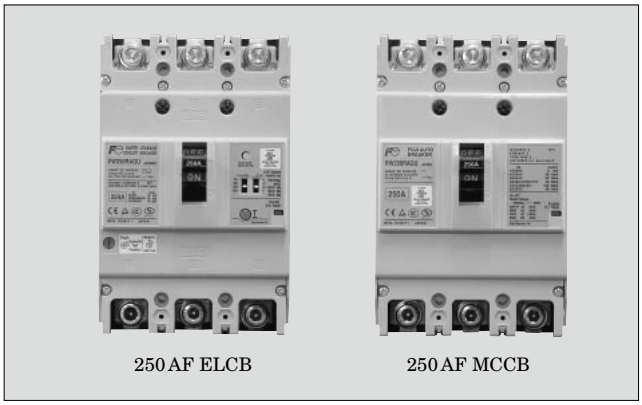


Fig.7 Appearance of MMS

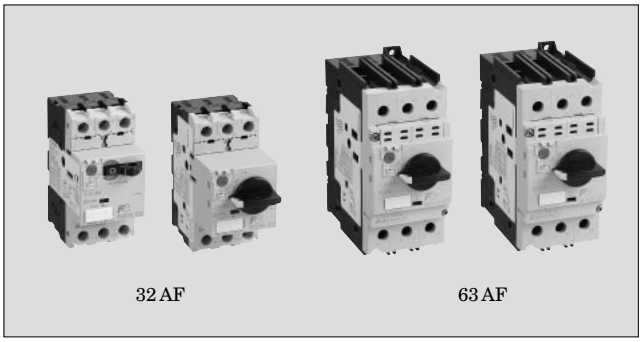
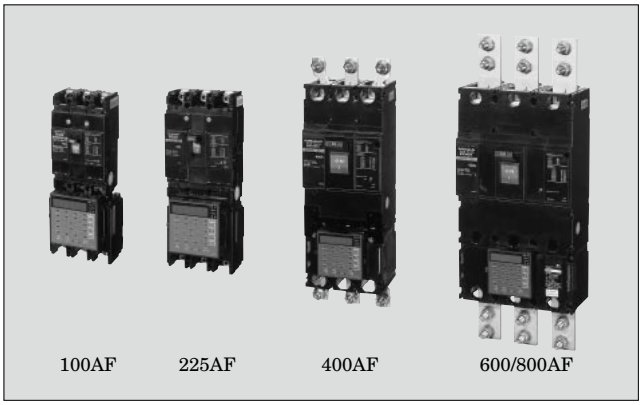


Fig.8 Appearance of FePSU Breakers



(1) Development of the new MCCB and ELCB series

Figure 4 shows the schedule in Japan for changing over from the previous JIS to the new JIS that conforms to IEC standards. During this transition period in Japan, low voltage circuit breakers must be used according to whether they support "existing electrical installations" or "IEC-based electrical installations." Because this problem is common to all countries throughout the world, Fuji Electric has proposed the concept of the new global "G-Twin Breaker" as a solution. (See Fig. 5.) Figure 6 shows the appearance of an implementation of this concept in 250A frame (AF).

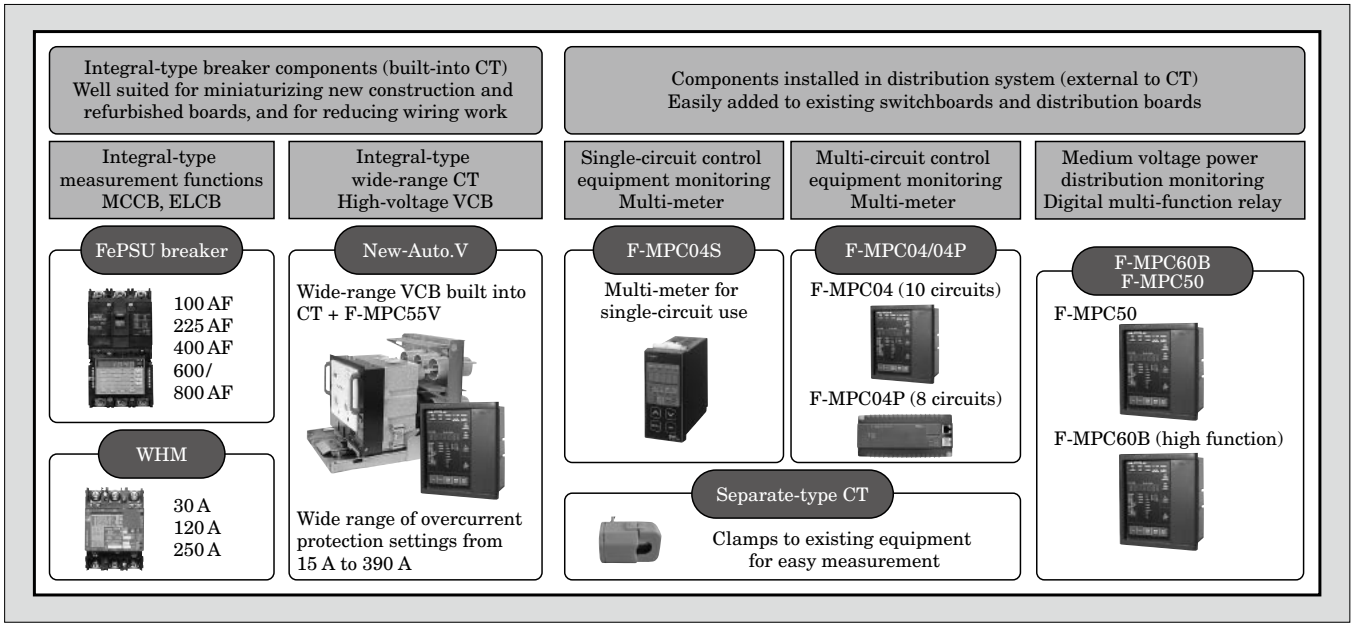
The G-Twin Breaker is a revolutionary product that has acquired certification of IEC (Europe), new JIS (Japan), GB (China) and UL (United States) standards with a single circuit breaker unit, while maintaining the Japanese standard dimensions for circuit breakers. In particular, the capability to use this single circuit breaker unit also for 480 V delta circuits (UL) is an important advantage, as such dual use had been difficult to establish previously.

For further details, please refer to the separate article "New Global MCCB/ELCB G-Twin Breaker Series" in this special issue.

(2) MMS that achieves a new type of electric motor protection

IEC standards for the protection of electric motors

Fig.9 Product line of power distribution monitoring system components



in electrical installations contain many safety related items. The newly developed MMS is a compact-size motor breaker that realizes overcurrent protection for each motor branch circuit. The smallest frame size is 32AF, having a width of 45 mm in accordance with the new dimensional standards selected for compactness. Furthermore, the MMS also features a high interrupting capacity rating of 50 kA (400 V AC) and current-limiting performance similar to that of a fuse. (See Fig. 7.) The use of this product enables improved backup protection for downstream series-connected devices, such as a magnetic contactor, and wire protectors. Moreover, the MMS has obtained UL508 type E certification as stipulated in UL 508A for "industrial control gear," therefore, it is suitable for use in branch circuit protectors in the United States.

For further details, please refer to the separate article "Fuji Electric's New Global Motor Control Series" in this special issue.

(3) "FePSU Breaker Series" equipped with wattmeter

Users want to measure the amount of electricity used, and efforts to reduce the consumption of energy not only for compliance with energy-saving standards, but also as an increased awareness for reducing the energy consumed to lower the cost of production. Based on this need, Fuji Electric has developed and is supplying the "F-MPC Series," which is suitable for the monitoring and control of electric power in low voltage installations and has received favorable reviews. We have also developed a product series of wattmeter-equipped "FePSU Breakers" that are suitable for new installations. Accordingly, the components to network low voltage power distribution system and to support energy conservation constitute the product lineup shown in Fig. 9 from which products can be selected corresponding to the diverse needs of the energy monitoring and control field.

5. Conclusion

This paper has presented an overview of the changing circumstances for low voltage circuit breakers, then has analyzed the associated customer needs and described examples of Fuji Electric's response to those needs. Low voltage circuit breakers are the model most influenced by the harmonization with IEC standards as a result of the TBT agreement of the WTO. As actual application progress, Fuji Electric intends to continue to provide solutions to customer problems arising during commercial operation. The authors hope that this paper will be beneficial for the globalization of low voltage electric installations.