

Present Status and Future Outlook for Low-voltage Distribution Switching Equipment and Monitoring Control Equipment

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1. Introduction

Instrument products for low-voltage distribution switching equipment and monitoring control equipment are being used in control panels and distribution panels as critical protection and switching control equipment for low-voltage electric equipment. These instrument products are used not only with the domestic equipment of our customers in Japan but also are being exported for use with overseas equipment.

Additionally, based on the trend of increased local procurement by overseas companies, the globalization of product performance and ability to respond rapidly to requests of overseas markets are important.

This paper introduces characteristics of Fuji Electric's new product series developed in response to market trends for instrument products, and discusses Fuji's plans for future efforts.

2. Trends of Low-voltage Distribution Switching Equipment and Monitoring Control Equipment and Fuji Electric's approach

2.1 Market trends

The global market for low-voltage distribution switching equipment and monitoring control equipment is exhibiting strong growth in India, an economically developing country representative of the BRICs and having a large concentration of IT information companies, and in China where industrial and economic activity is spreading from coastal to inland regions, a social infrastructure is being developed and capital is actively being invested in industrial equipment, and the economic trends of expansion in China and other Asian regions are expected to continue in the future.

Meanwhile, in Japan, affected by the recent sub-prime problem in the US, the rise in crude oil prices, and a sudden rise in materials costs, there is a sense of uncertainty regarding future business conditions, but in the flat panel display and semiconductor industries, capital investment continues to be strong in equipment and facilities that have positioned Japan as a produc-

tion center for high-value added products.

Furthermore, in the automobile industry and the machinery and equipment industry, as represented by machine tools that support the automobile industry, the shifting of production sites to overseas locations and the participation in overseas markets is developing dynamically. Such global investment in equipment and facilities is expected to continue to increase for each industry, both in Japan and overseas.

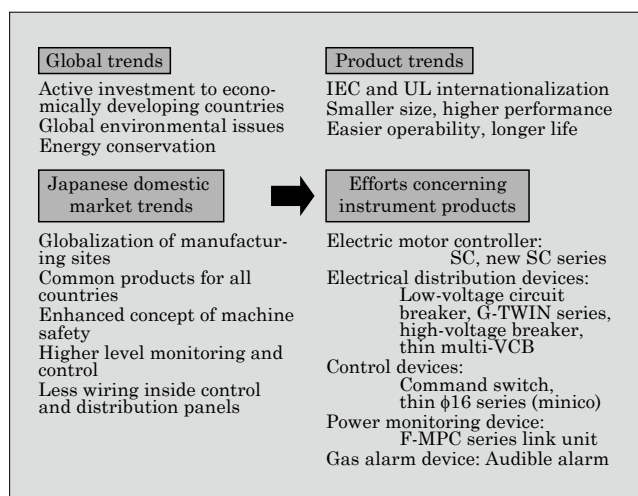
2.2 Technical trends and Fuji Electric's approach

In order to respond accurately to the abovementioned type of market trends as a global top-level component manufacturer, the core technical development necessary for globalization of instrument products forms a basis upon which the ascertaining of customer requests and trends of standards for the machinery and equipment industry and the electrical distribution and control panel industry in which products are used, the determination of the market direction, and the development of ongoing new standard products and creation of new markets will continue to be of vital importance.

For the instrument products used in electrical facilities and equipment in Japan, a new JIS (Japanese Industrial Standard) that incorporates IEC standards (international standards) into the JIS for individual instrument products has been issued, and the JIS C 8201 series, harmonized with the IEC 60947 series, has been established for electromagnetic switch and molded case circuit breakers. This new JIS cites both the Japanese domestic extended official regulations and the public building construction standard specifications, and equipment designers are able to use new JIS products in the same manner as with conventional JIS. The introduction of international standards is also expanding to the general concept of safety for machinery and equipment. In 2006, the Japanese "Industrial Safety and Health Law" was revised, and as a philosophy for machine safety and electrical safety, the implementation of risk assessment to diagnose risk was mandated. With this revision, from the designing of the machine type through all phases of the machine lifecycle, hazards are identified and the removal or minimization of

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Fig.1 Market trends and Fuji Electric's efforts concerning instrument products



risk (danger) is sought, and the concept of functional safety is incorporated into not only the hardware, but also the software, i.e., into a series of operation control circuits that range from operation to risk detection and stopping. Fuji Electric intends to create switching equipment and control equipment products that incorporate an HMI (human-machine interface) concept that gives consideration to the safety of the operator based on the development of highly reliable and low-voltage distribution equipment products that meet new JIS, IEC and UL standards.

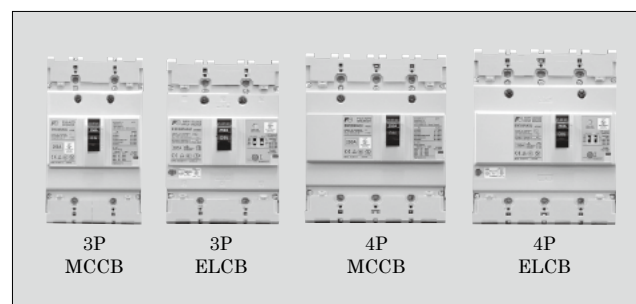
Moreover, responding to the issue of global warming, 2008 marks the beginning of the first commitment period for the "Kyoto Protocol," and countries throughout the world are accelerating full-fledged efforts to reduce energy consumption. In response to increased requests for recording and managing daytime and nighttime load fluctuations and the detailed changes in the usage of electric power that accompany an increase or decrease in production quantity, increased requests for the monitoring of each production facility, and customer needs for both concentrated monitoring and dispersed monitoring of equipment in the power monitoring and control field, the functionality of products used to construct a monitoring system easily must be enhanced in order to support the various energy sources handled by customers.

Figure 1 shows the market trends and Fuji Electric's efforts concerning its instrument product group. The latest new products are introduced below.

3. Approach to Low-voltage Breakers

In 1990, Fuji Electric launched the world's first "Twin Breakers" that unified the external dimensions of molded case circuit breakers (MCCB) and earth leakage circuit breakers (ELCB). As a result of the tremendous response and support from our customers, this concept has become the "de facto standard" in

Fig.2 G-TWIN series (250 AF)



Japan. In recent years, the trend toward globalization in the low-voltage breaker field has accelerated as a result of the harmonization of the conventional JIS with IEC standards. However, due to differences in distribution and control systems and in safety and protection concepts, the IEC standards seem to be coexisting simultaneously with the UL and CSA standards. For this reason, manufacturers from each country had to provide two series of breakers to meet each of these standards.

In addition to providing the required performance of the IEC standard, the provision of the required performance of the UL and CSA standards, which had only been realized with large breakers, achieved "true globalization", and in response to requests for current-limiting interruption performance and earth leakage detection performance, which are highly difficult to realize for both standards, Fuji Electric comprehensively reviewed each individual elemental technology, and moved forward with innovative development. As a result, the 125 to 400 AF (ampere frame) "G-TWIN series" of truly global twin breakers shown in Fig. 2 was introduced to the market. Consequently, the user-side confusion concerning the application of products in the global market was resolved all at once.

The main features of the G-TWIN series are listed below.

- While maintaining the Japanese domestic standard compact size, new JIS/IEC (Japan, Europe), GB (China) standard certification, and UL489 (United States) standard certification has been acquired for the same product (an industry-first)
- Applicable to 480 VAC delta circuit systems of UL489
- Compatible with IEC 60947-2 Ed.III for ELCBs, ensures safety of equipment that detects ground faults reliably even during the loss of one phase, and is equipped with a dielectric test switch for maintenance-use (an industry-first).
- Two series are provided: a G-TWIN global series that supports all standards, and a G-TWIN standard series that support new JIS/IEC and GB standards
- The same internal accessories can be used for both the 125 AF and 250 AF

Owing to the above characteristics, the G-TWIN series meets the requirements of customers considering the deployment of global sites, and are innovative new products that eliminate the labor and complexity involved in selecting equipment models, and contribute to an overall improvement in efficiency.

4. Approach to Operation Indication Devices

Fuji Electric sells operation and switching indicators used in industrial machines, tooling machines, and control panels and distribution panels under the commercial name of “command switches,” and provides a lineup of various such products ranging from flat command switches to command switches for panel cut-out dimensions of $\phi 8$ to $\phi 30$, having a high-brightness display functional, and also including high-function products equipped with an emergency stop pushbutton switch.

Command switches are commonly used in control panels and operator panels (pendants) as HMI devices for providing instructions to machines based on human judgment, and thinner type command switches are increasingly being requested to support the miniaturization of control and operation panels, while maintaining such basic conventional control functionality as safety action mechanisms and switching endurance performance. For this purpose, Fuji Electric has developed the new “minico series” of $\phi 16$ command switches that have a depth dimension of 28.4 mm, which is a significant reduction in size from the 42.5 mm depth of the existing series of $\phi 16$ command switches.

The reduction in size of the minico series has been achieved by eliminating unnecessary stroke length of the contact actuator linked to the control part, and integrating contact structure. Moreover, a click sensation indicating that an operation has been made is also provided. For illuminated products, a small LED, technology for mounting chips onto a lead frame, and thin reflectors were developed, and a reduction in overall size was realized by combining these developments. The main features of the minico series shown in Fig. 3 are as follows.

(a) Simplification of wiring tasks and improved

Fig.3 minico series



safety through development of sockets and protective covers usable by all switches and indicator lamps

- (b) Thin and high-strength lock structure and high brightness illumination technology enable improved design of panel surface operation part
- (c) Acquisition of new JIS/IEC, GB and UL/cUL standard certification in standard products

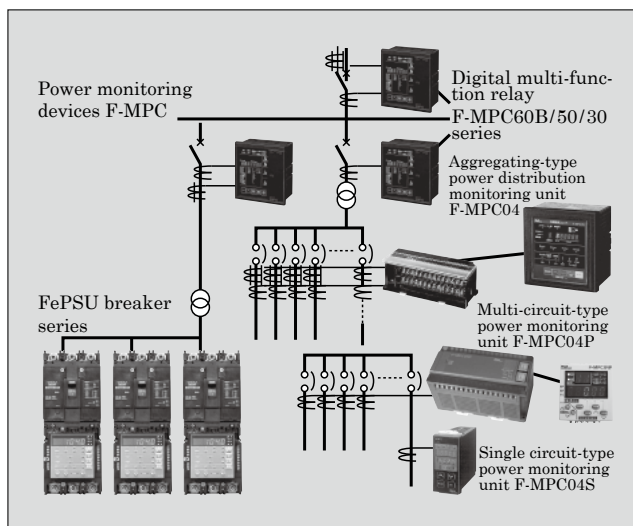
5. Approach to Power Monitoring Devices

In distribution equipment, epitomized by the rapid popularization of OA (office automation) device and information networks, based on advanced information technologies and enabled by the automation and higher functionality of manufacturing equipment, multi-functionality and higher reliability are requested in order to improve the visualization of the operating status of equipment. Moreover, regarding electric power energy, a reduction in the amount of future energy usage through more precise recording, management and verification of results is requested, and greater multi-functionality and enhanced system compatibility is also increasingly requested.

Against this backdrop, Fuji Electric has developed the “F-MPC series” of digital multifunctional relay and power monitoring units, and through combining and integrating the multiple functions of power distribution equipment, aggregating multiple circuits into modular units and adding integrated high-voltage and low-voltage circuit breakers, has provided a series of high-voltage to low-voltage electrical distribution equipment as shown in Fig. 4. As a product that meets the needs of the times and incorporates new technology, the F-MPC series has been well received in applications to new equipment or during the replacement of equipment, i.e., renewal or upgrading.

Application fields and uses are recently being narrowed and refined, and consequently a system link

Fig.4 Power monitoring devices



unit, high/low voltage transformer panel unit and a transformer protection unit that achieve optimum composite integration have been commercialized. Moreover, an “F-MPC Web unit” that easily connects these field devices via a LAN and enables centralized management has been commercialized as a product that facilitates systemization.

6. Increased Requests for Safety Devices

The recent trends of safety standards, which are very influential, and Fuji Electric’s approach corresponding to the abovementioned instrument products are described below.

6.1 Trends of international standards

In the EU (European Union), a machine directive, a low-voltage directive and an EMC directive have previously been issued, and all types of machines entering the EU undergo a conformity evaluation and are tested based on EN standards that match each of the directives. For machinery and equipment, EN 292 that prescribes basic concepts and design principles relating to machine safety has been adopted as an international safety standard and issued in 2003 as ISO 12100 “Safety of machinery – Basic concepts, general

Fig.5 New international trends in response to EU-issued safety directives

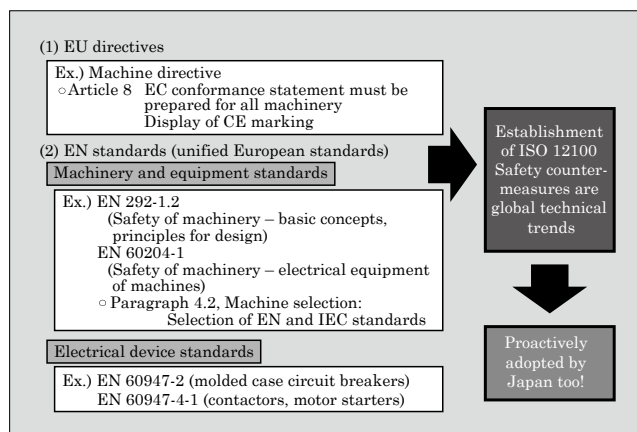
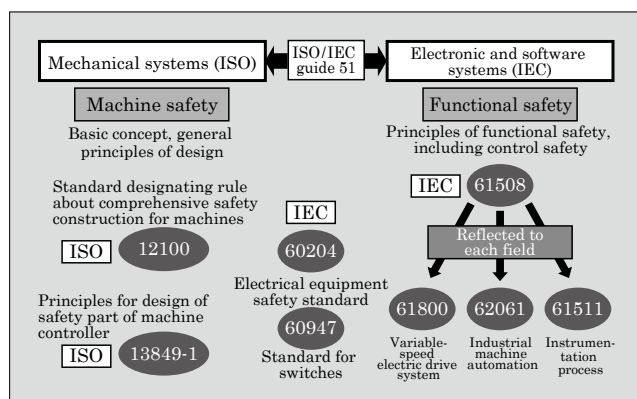


Fig.6 General overview of international safety standards



principles for design”. The gist of this standard is that risk assessment is performed based on the concept that “machinery fails and people make mistakes,” and that “the establishment of a risk reduction process” is required in order to create safety for the equipment and facilities. From the aforementioned basic general standards concerning machinery safety, various international safety standards have been issued including ISO 13849-1 “Safety-related parts of control systems Part 1: General principles for design” which was adopted as an international standard from EN 954-1 for machine system safety, IEC 60204-1 “Electrical equipment of machines Part 1: General requirements” for electrical system safety, IEC 61508 “Functional safety of electrical/electronic/programmable electronic safety-related systems” for control system safety, etc., and the creation of comprehensive safety is of critical importance. (See Figs. 5 and 6.)

6.2 Trends of Japanese domestic standards

ISO 12100, ISO 13849-1 and IEC 61508 have been incorporated into JIS with JIS B 9700, JIS B 9705 and JIS C 0508, respectively, and other international standards are sequentially being incorporated into JIS. As shown in Fig. 7, in Japan, in the “Industrial Safety and Health Law” the “survey of risks and hazards” was cited in April 2006, and the “Guidelines for the Comprehensive Safety Standards of Machinery” was revised in July 2007. As a result, “when new machinery or equipment is installed or changed, or when a work method or procedure is changed” the implementation of risk assessment to diagnose risk is mandated, and even in Japan, designers, manufacturers, installers and operators of machinery and equipment must continuously strive to ascertain safety-related standards and technical trends, and do their best to ensure safety.

6.3 Control panel safety system

Fuji Electric’s approach to safety for control panels for machinery and electrical equipment is explained through a description of Fuji’s product constitution below, using the example of IEC 60204-1, which lists

Fig.7 Trends of safety standards and regulations (in Japan)

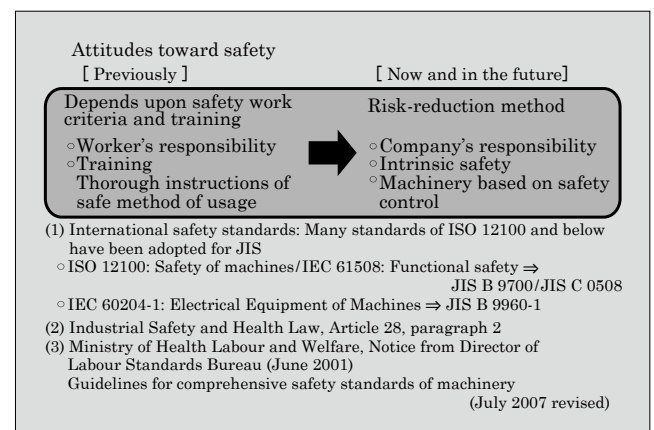
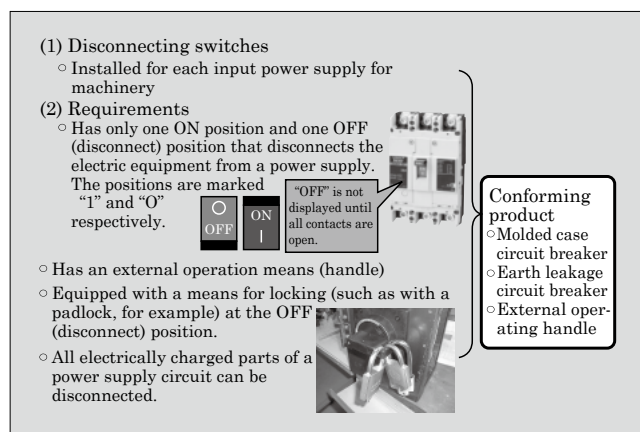


Fig.8 IEC 60204-1 requirements and conforming products



requirements for the power supply isolating devices, overcurrent protection devices and control circuits for electrical equipment.

(1) Power supply isolating device

A power supply isolating device is installed for each input power source to a machine, and conforms with the isolation function prescribed in IEC 60947-2 (JIS C 8201-2-1, 2). As shown in Fig. 8, MCCB, ECCB and external operating handle of G-TWIN series standard products comply with such diverse requests as the provision of ① an OFF/ON indication, ② an external operating means, and ③ a means for locking at the OFF (isolation) position.

(2) Electromagnetic contactor, emergency stop pushbutton switch

Control functions during a malfunction are requested to "use appropriate means to reduce risk during a malfunction" and "to provide duplexed contacts or the like by using a switch equipped with a positive opening mechanism" and so on, and Fuji Electric's electromagnetic contactor "SC series" (SC-03 to SC-N16) is equipped with a safety opening mechanism as a standard feature, and conforms to the "mirror contacts" specified in appendix F of IEC 60947-4-1. By using Fuji Electric's emergency stop pushbutton switch and electromagnetic contactor, a control circuit of ISO 13489-1 safety category 3 or above and that detects single or multiple faults can be configured easily. In particular, an emergency stop pushbutton switch is an operating and opening/closing device that is important for operator safety and machine safety, and further safety design improvements, including the provision of the customer desired operability, must be pursued in the future. Figure 9 shows the evolution of the emergency stop pushbutton switch to support safety requirements.

(3) Support of control panel

Figure 10 shows the IEC 60204-1 safety requirements and corresponding products for the control panels of machinery and equipment. As shown in the figure, in response to the safety requirements, Fuji Electric has prepared a diverse lineup of instrument

Fig.9 Evolution of pushbutton switch for emergency stopping

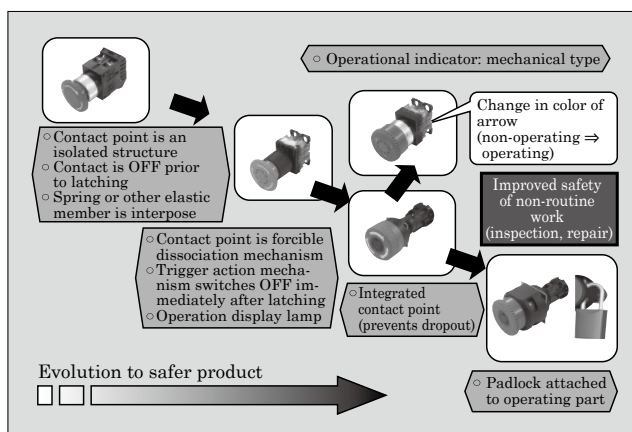
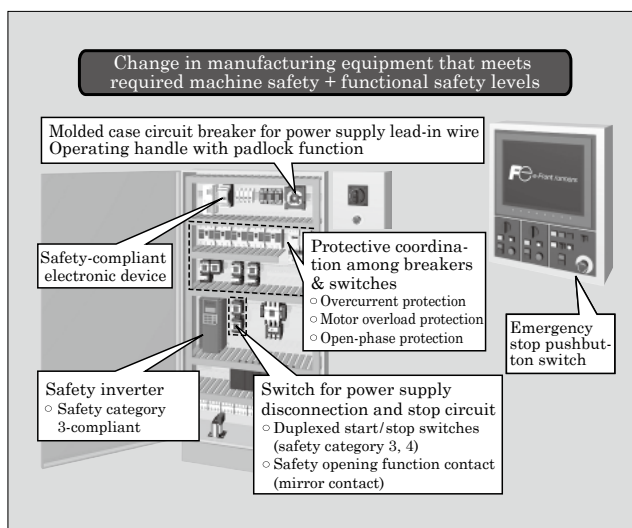


Fig.10 Safety requirements for the control panels of machinery, and the corresponding products



products which also support the risk and safety categories listed in ISO 13489-1. In the future, Fuji Electric will continue to develop instrument products that are responsive to safety needs.

7. Postscript

Market trends of low-voltage distribution switching equipment and monitoring control equipment and recently launched new products have been described, and Fuji Electric's efforts involving technical trends have been discussed above. Requests for systemizing and enhancing the safety of low-voltage distribution switching equipment and monitoring control equipment are expected to diversify and become more sophisticated in the future. Based upon these trends and responding to market needs with high-reliability new technology, and as a supplier of continuing global products, Fuji Electric will strive to make positive contributions worldwide, to continue to seek the opinions of our customers, and to realize additional improvements.



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