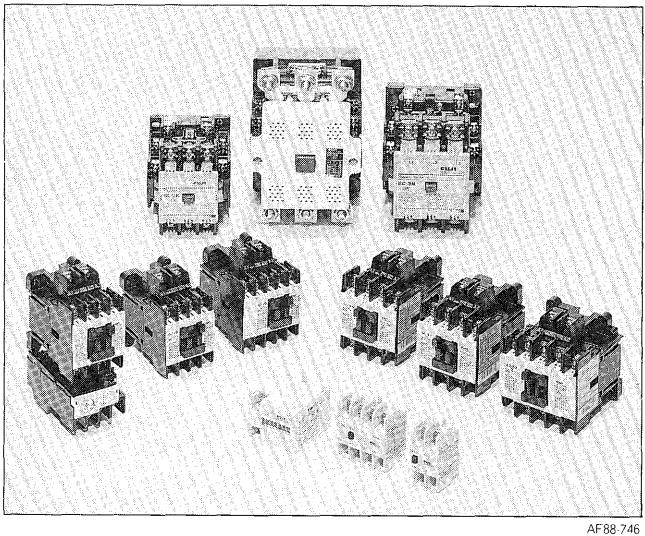


TECHNICAL TRENDS OF MOTOR STARTERS AND THE DEVELOPMENT OF THE NEW SC SERIES

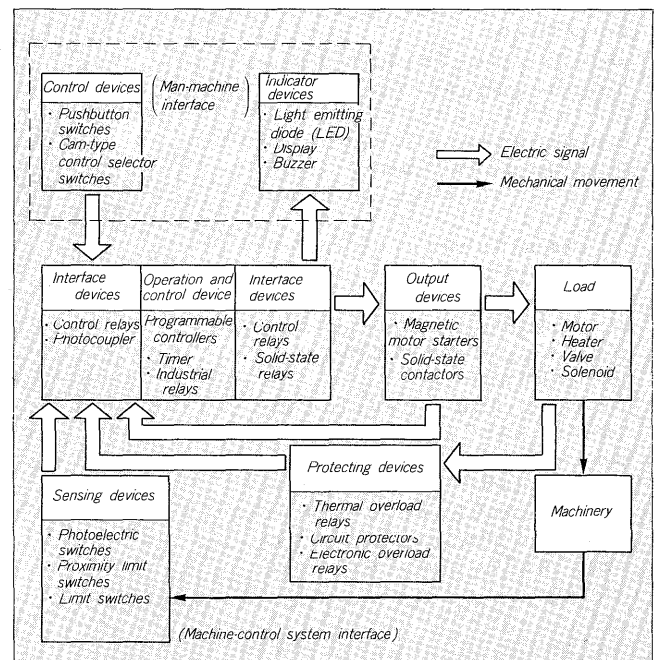
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Fig. 1 1 Fuji new series motor starters



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Fig. 2 Control system composition and general purpose control devices



1. FOREWORD

Control technology is one field of scientific technology which is continuing to advance.

The control components which make up the control system of FA, FMS, and other automated systems include the programmable controller (PC), sensing devices, magnetic motor starters, and other general purpose control devices. Even these devices give create new problems and needs, and new needs are being revealed and the approach to their solution is beginning.

Dealing with these problems is embodied as products with a high order of functions and performances achieved by integration of technology already established and technology being fixed and the addition of new technological seeds. Such technological progress is not limited, even if temporarily static.

The Fuji Electric motor starters introduced in this special issue were born from the needs of the time by high economic growth, oil shock, rise in the price of silver, and other severe changes in the market environment and have continued to develop and answer these with new viewpoints and technological seeds since they were introduced in 1954 and have built today's position.

This special introduces the trends of motor starters and outlines the design concept, development objective, and features of related products developed by Fuji Electric.

2. TRENDS OF GENERAL PURPOSE CONTROL DEVICES

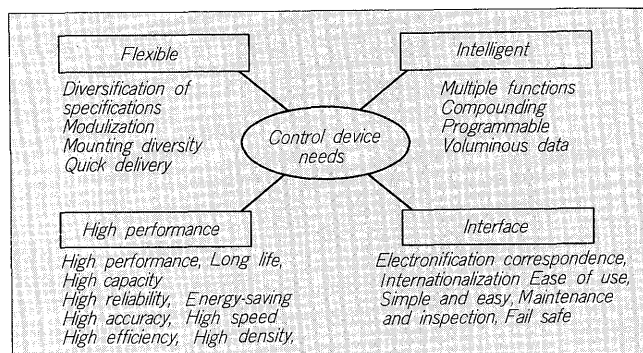
2.1 Technical trends of general purpose control devices and Fuji Electric response

General purpose control devices and the configuration concept of a system using them are shown in Fig. 2.

General control systems roughly consist of controllers, indicators, and other man-machine interfaces, sensing devices for feeding back the equipment status to the operation and control unit, and output devices which drive the machine by means of the operated result.

Various electric devices or equipment, including gen-

Fig. 3 Control devices needs



eral purpose control devices, meet diversification of market needs with microcomputer and IC applied microelectronics (ME) as the key technology and are changing substantially.

Therefore, regarding the technical trends of general purpose control devices, electronic devices and mechanical devices with mechanical contacts cannot be discussed without discussing the relationship with ME technology.

That is, smaller and more reliable electronic devices with more advanced functions are pursued by applying the microprocessor, IC, etc. For devices with mechanical contacts, coordination of specifications is becoming important for use with electronic devices.

At Fuji Electric, the various needs of control devices can be summarized in the four key words flexible, intelligent, high performance, and interface, as shown in Fig. 3.

Suitable electronification of control devices is an important point in product development as seeds which embodies such needs.

There are the following cases as the form of electronification:

- (1) Devices which are entirely electronic (PC, photo-electric switches, proximity limit switches, solid-state contactor)
- (2) Devices which are partial electronic (super magnetic switches)
- (3) Devices coordinated with related electronic devices (high-sensitivity contactor)

Electronification of devices takes these various forms, but since electronic devices and devices with mechanical contacts are used together in systems, they must be connected to improvement of the overall functions and the securing of reliability as a system.

Based on an understanding like the above, Fuji Electric has undertaken product development with the following points as its aim:

- (1) Widening of the range and flexibility of product specifications so that they can be used with various systems.
- (2) Increasing the additional value by means of composite functions.
- (3) Contributing to making systems more intelligent and improving performance and handling.

2.2 Technical trends of motor starters

When focussed on motor starters, the previously des-

cribed needs for control devices become the following concrete problems:

(1) Flexible specifications and functions

The development and popularity of motor starters is accompanied by a demand for products with the optimum specifications for the usage objectives of the user. Performances and functions have been diversified to meet this demand.

A supply system capable of delivering these various special specifications products quickly is also demanded.

Meeting the demand "quick delivery of special specifications products" is a problem for this need. There are many areas which depend on renovation of the product structure from the standpoint of overcoming this theme.

Concretely, the contact part, coil part, magnet part, and other parts of the contactor are unitized and the option functions are modulized and added to the body.

Typical option units are auxiliary contacts, mechanical latch, mechanical interlock, coil surge suppression unit, etc.

(2) Performance improvement

From 1955 to 1965, the points of dispute of motor starter competition were contact performance and long life. As a result, Fuji Electric was the first to realize a making and breaking capacity of at least 10 times the rated current, intermittent duty of at least 1200 times/hour, mechanical endurance of at least 10,000,000 operations, electrical of at least 500,000 to 1,000,000 operations. This performance is still one of the highest level standards in the world.

Recently, with the advance of machines and the rise in the number of units installed, lightening of contact replacement and other maintenance work is desired.

On the other hand, the main application of the motor starter is motor switching. Lately, they have been used in switching heaters, power factor improvement capacitors, etc. and the load devices are diversifying. Especially, closing of capacitor circuits generates a large inrush current and accelerates contact wear noticeably.

Extending electrical endurance by minimizing contact wear is an effective way to answer these needs.

(3) Dealing with electronification

Lately, control systems have been shifting from relay sequence to PC. As a result, a strong demand has arisen for improvement of the contact reliability of the auxiliary contacts of motor starters and the contacts of auxiliary relays, and signal transmission between motor starter and electronic device must be positive.

That is, a low contact fault failure rate is demanded even for low level voltage and current. For example, a failure rate of about 10^{-7} to 10^{-8} is demanded even at 24V, 10 mA level. When used by combining a motor starter and electronic device, the ability to directly switch the motor starter with the low output current of the electronic device, a means of suppressing the surge generated by the magnet coil, etc. are demanded.

(4) Pursuit of ease of use

"Ease of use" of a motor starter is improvement of installation and wiring work when manufacturing a the distribution panel and equipment and improvement of

maintenance and inspection work.

The following should be satisfied:

- Standardization of installation dimensions regardless of the frame size.
- Easy installation work (screw tightening, one-touch installation)
- Clear classification of main circuits, operation circuits, and auxiliary circuits and simple wiring work.
- Easy to see type designation, ratings, terminal numbers, etc. in the installed state.
- Easy replacement of contacts and coils.

(5) Dealing with internationalization

When a motor starter is exported singly or installed in machinery and equipment, it must meet overseas standards. When exported to the United States and Canada, meeting UL and CSA standards is essential.

IEC standards unify the installation dimensions and outside dimensions at integer multiples of 5 mm, that is, 5 mm modules.

The main circuit, auxiliary circuit, and operation circuit terminal numbers and marking symbols are also prescribed.

For West Germany, a law (VBG 4) was established to prevent electric shock accidents to workers and VDE 0106 Teil 100 was established to solidify it. When exporting to Europe, these standards must be met.

(6) Improvement of safety

Generally, live parts of the devices inside the panel are

equipped with a protection cover to prevent the worker from touching them inadvertently.

Measures which prevent the arc at overcurrent breaking from being blow out to the front are also desired.

3. DEVELOPMENT OF NEW SMALL MOTOR STARTERS SC SERIES

3.1 Development aims

In 1954, Fuji Electric placed the revolutionary small motor starter RC3931-1 on sale. In 1984, the medium and large types under model change as the New SC Series and has reached today with the strong support of users. During this time, smaller size, higher performance, lower energy, silver-saving design, ease of use and other product improvements were made to meet market needs through the high economic growth period, oil shocks, rise in the price of silver, and stable economic growth period and contributions were made to automation and rationalization of the facilities of the industrial world and they have come to lead the industry.

Small models under 3.7 kW have not undergone a basic model change since they were placed on sale, but are highly valued by users for their small size, long life, and high reliability.

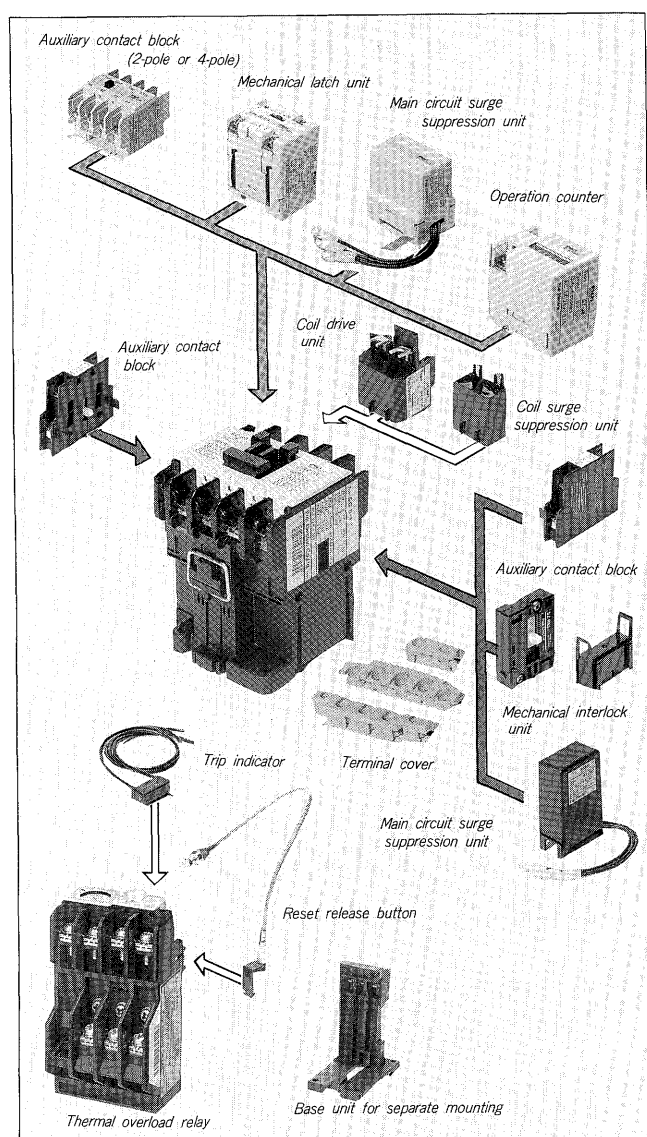
However, as discussed in paragraph 2, the demand for more diverse and advanced motor starters is increasing with

Table 1 Ratings of new SC series magnetic motor starters

Abbreviation	Model		Rated capacity (kW)			Rated current (A)					Rated thermal current (A)
	Contactor	Starter	3-phase squirrel-cage motor (AC3)			3-phase squirrel-cage motor (AC3)			Resistive load (AC1)		
			200V ~ 240V	380V ~ 440V	500V ~ 550V	200V ~ 240V	380V ~ 440V	500V ~ 550V	200V ~ 240V	380V ~ 440V	
03 type	SC-03	SW-03	2.2	2.7	2.7	11	7	6	20	20	20
0 type	SC-0	SW-0	2.7	4	5.5	13	9	9	20	20	20
05 type	SC-05	SW-05	2.7	4	5.5	13	9	9	20	20	20
4-0 type	SC-4-0	SW-4-0	3.7	5.5	7	18	13	13	25	25	25
4-1 type	SC-4-1	SW-4-1	4	7.5	9	18(19)	17	17	32	32	32
5-1 type	SC-5-1	SW-5-1	4	7.5	9	18(19)	17	17	32	32	32
1N type	SC-1N	SW-1N	5.5	11	11	26	25	20	50	50	50
2N type	SC-2N	SW-2N	7.5	15	15	35	32	26	60	60	60
2SN type	SW-2SN	SC-2SN	11	22	22	50	48	38	80	80	80
3N type	SC-3N	SW-3N	15	30	37	65	65	60	100	100	100
4N type	SC-4N	SW-4N	18.5	37	37	80	80	60	135	135	135
5N type	SC-5N	SW-5N	22	45	55	93	90	90	150	150	150
6N type	SC-6N	SW-6N	30	55	55	125	110	90	150	150	150
7N type	SC-7N	SW-7N	37	75	75	150	150	120	200	200	200
8N type	SC-8N	SW-8N	45	90	110	180	180	180	260	260	260
10N type	SC-10N	SW-10N	55	110	132	220	220	200	260	260	260
11N type	SC-11N	SW-11N	75	132	160	300	265	230	350	350	350
12N type	SC-12N	SW-12N	110	200	225	400	400	360	420	420	420
14N type	SC-14N	SW-14N	150	300	375	600	600	600	660	660	660

< Notes > (1): Capacity rating in () of rated current is applicable when used without thermal relay as magnetic contactor.
(2): Temperature in applied enclosure is 50°C or less.

Fig. 4 Various optional units



electronification and systematization. To meet these demands, the basic product construction must be reviewed and a model change of small models has now been boldly undertaken.

This development combined our application technology, development technology, product know-how, and production technology accumulated during our long experience up to now. The following improvement points were stressed:

- (1) Flexibly meeting diversifying needs
- (2) Specifications internationalization and higher performance
- (3) Coordination from the standpoint of application with related devices which advance electronification
- (4) Pursuit of ease of use and safety

Our intent was improvement not only of the performance hardware, but also improvement from a wider field of view which considered contribution to total cost reduction of the user.

Needless to say, for a product to be accepted, quality,

Table 2 Ratings of new series industrial relays

Model		SH-4	SH-4		SH-5	
Number of contacts		4	8 (with auxiliary contact block)		5	
Contact configuration		4a 3a1b 2a2b	8a 7a1b 6a2b	5a3b 4a4b	5a 4a1b 3a2b	2a3b 1a4b 5b
Contact ratings	Rated thermal current		10A			
	Rated operational current	AC	110V	220V	440V	660V
		Inductive (AC11)	6A	3A	1.5A	1.2A
		Resistive (AC13)	10A	8A	5A	5A
		DC	24V	48V	110V	220V
		Inductive (DC11)	3A	1.5A	0.55A	0.27A
		Resistive (DC13)	5A	3A	2.5A	1A

cost, and delivery are of utmost importance, but even though it is for industrial use, outside design is also an important point. Whereas the old series was black, the appearance has been completely changed as the orange line new SC Series with a cream cover with orange lines provided at the front.

Development incorporated the opinions and demands of users and user intent was strengthened. This series concentrates the total power of Fuji Electric and delivers the highest product quality by the newest FMS production system and we are confident that it is sure to satisfy.

3.2 Models and ratings

The new SC series is made up of 200 V, 4 kW and less small motor starters, magnetic contactors, thermal overload relays, and industrial relays for control use and option units. The models and ratings of the entire series, including the 200 V, 5.5 kW and greater SC series, are shown in Table 1.

The models and ratings of the industrial relays are shown in Table 2. Typical option units are shown in Fig. 4.

The new SC Series is described in detail in another article in this special issue.

4. CONCLUSION

The technical trends of the motor starter and related devices and the new SC Series development organization, etc. were introduced above.

We will be happy if this new series contributes to the progress of industry and is highly evaluated by users.

Control technology amply acknowledges the support of various industries and will spur future technical research and efforts are being made in product development and improvement to meet new needs. The guidance and encouragement of users and readers is requested.