

NEW FUJI AUTO BREAKER SERIES LISTED BY UNDERWRITERS LABORATORIES INC. FOR BU SERIES

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1 INTRODUCTION

Molded case circuit breakers (abbreviated as MCCB) have made a large success and widely diffused at present as the main equipment representing protectors against overcurrent for low-voltage circuits. Together with the recent demands for larger capacity and diversification of electric installation for factories and buildings, reliability in power supply of the low-voltage distribution system plays more and more important role and it constitutes a big problem how to plan high reliability distribution system aiming, at the same time, at obtaining a high economicity. Also, for MCCB that assumes responsibility for protecting low-voltage circuits against overcurrent, the demands are many for enlargement of rated current and interruption capacity taking into due consideration of protection and coordination with the system and improvement of maintenance efficiency, as well as enhancement of their functionality and performance, in particular for large-capacity MCCB's used for the mains in the vicinity of power source.

Also, general tendencies for medium and small capacity MCCB's, stressing on the economicity, are demand for products that contribute for total cost down for users, that is, in concrete form, improvement of manipulability and safety, modularization of fundamental sizes, rationalization of mounting and connection and enlargement of the field of application through enlargement of rated interrupting capacity.

On the other hand, beside these apparatus, there are strong demands for MCCB's rich in higher degree of internationality accounting for demands from overseas markets. For this, industrial standardization is being propelled in international scale by IEC (International Electrotechnical Commission), still, since there are many countries overseas, where they have their own standards and laws for manufacture and use of electrical appliances, MCCB's appropriate for international market adapted for main standards of each country (IEC, BS, VDE, UL, NEMA etc.) are in demand. In particular, for electric facilities to be exported to industrialized countries as the United States and others are inspected and tested and often are obliged to use electric appliances authorized according to the standards of UL

(Underwriters Laboratories), and that goes without saying that our MCCB also are the object of such inspection, test and approval.

Fuji Electric, catching the technical trends swiftly, developed and manufactured before other firms could have done, utilizing fully application technology of electronics, system breakers (power breakers) and solid-state motor protection breaker, and obtaining the type approval from UL for our Fuji Auto-Breaker (abbreviated as FAB from now on), and at the same time, have taken due consideration of being able to contribute for improving the total cost performance for the sake of our customers through perfecting of 4-polar FAB performance and increase in interruption capacity of small-size economic type (E) and standard type (S).

This report introduces the outline of ratings and specifications of FAB's new series as well as their features and BU series approved by UL.

2 SPECIFICATIONS AND FEATURES OF FAB'S NEW SERIES

Table 1 shows the new series of FAB together with their specifications. It shows newly added types and improved versions in a separate way. This report introduces the concrete contents and features of the new products basing on the principle of the development and improvement of the new series.

2.1 Perfecting of small-size economic type (E) and standard type (S)

FAB of small-size economic type (E) and standard type (S) have been increased in their interrupting capacity so that they could covered more than about 90% of facilities using FAB's. and thus, the field of application of E and S series is widened.

- (1) To small-size economic series (E), (with 60mm in depth), EA50A, EA100H and EA225H are added. Furthermore, the interrupting capacity of EA100A are increased and their field of application expanded. As the products of this series have the same outer dimensions and mounting method, and as they have mounting compatibility, no modifications on the panel design and panel manufacture are needed and they can

Table 1 Fuji auto breaker series composition

			New products										Improvements		
Series			A Frame	30	50 60	100 150*	225 250*	400	600	800	1,000 1,200	1,600	2,000	2,500	3,200
E	Economical and compact series	Type	EA30	EA50A	EA100A	EA225A	EA400A								
		Outer dimensions (mm) a×b×c	75×96×60	EA50-60	EA100H	EA225H	(SA400K)	EA600A	EA800A						
		Interrupting capacity (kA) 220V/460V	2.5/-	2.5/-	10/7.5	18/10	35/22	210×265×103							
S	Standard series	Type	SA30	SA50-60	SA100H	SA225A, commercialized soon	SA400H	SA600H	SA800H	S1000 S1200	S1600A	S2000	S2500	S3200	
		Outer dimensions (mm) a×b×c	75×118×60	90×150×60	105×165×85	105×170×85	210×275×103			210×400×105	210×370×140	320×450×185	390×560×235		
		Interrupting capacity (kA) 220V/460V	5/2.5	10/7.5	85/42	50/25	85/42			85/50	130/65	130/85	130/85		
H	Current limiting double break system series	Type		SA54	SA104A	SA204H	SA404H	SA604H	SA804H	S1004 S1204					
		Outer dimensions (mm) a×b×c		120×500×60	140×165×86	185×2571×103	280×275×103			280×400×105					
		Interrupting capacity (kA) 220V/460V		5/10	18/30	42/85	42/85			50/85					
P	Power breakers	Type			H100	H225	H400	H600	H800						
		Outer dimensions (mm) a×b×c			110×190×190	140×259×220	210×284×230	210×406×270							
		Interrupting capacity (kA) 220V/460V			100/100	100/100	100/100	100/100							
BU	UL approved series	Type													
		Outer dimensions (mm) a×b×c													
		Interrupting capacity (kA) 240V/480V													
SE	Solid-state type motor breaker	Type	SE30CM	SE50CM											
		Outer dimensions (mm) a×b×c	75×96×60	75×96×60											
		Interrupting capacity (kA)	2.5/-	2.5/-											

be mounted as they are.

- (2) It was made possible to set auxiliary switch and alarm switch on EA30.
- (3) SA50A and SA225A were newly added to Standard type series (S). And interrupting capacity of SA50 and SA100A was increased. A higher economicity on part of users is expected in the application of FAB.

2.2 Perfectioning of protection and coordination

(1) Power breaker

A new series was added under the name of Power Breaker from 1,600A frame to 3,200A frame as the system breaker. They are the new type of breakers that change completely the image of conventional MCCB's, and they can be applied, besides the conventional field of application of MCCB's, to spot network, bus tie and power source switching that have been traditionally the field of application of air circuit breaker (ACB). They can work as breakers of supply mains. Besides the features of MCCB's of being (1) compact, (2) economic and (3) diversified connection systems, the new series are provided with the following features, as (4) possibility of instantaneous

closing, (5) possibility of reverse connection, (6) high short-time dielectric rigidity (7) tripping characteristics through solid state trip unit, adjustable in wide range and high precision, mounting a microcomputer control system. (8) overload and failure mode operation display, (9) abundant interlocking system. With this new innovation, the optimum protection and compatibility among high and low voltage devices of distribution board, perfectioning of selective interruption and improvement of maintainability can be expected to attain with economicity.

(2) Electronic motor breaker

Recently for improvement in reliability and protective function of electric motor protector, besides the protection against overload and short circuit, a protective function for phase failure. In order to cope with this demand, electronic motor breaker 30A frame and 50A frame were added to the series. The following is their features.

- (a) Set current can easily be adjusted by dial manipulation according to the full load current of the electric motor.
- (b) The new addition has the same modular construction as that of existing series, that is, compact and

light in size and weight.

- (c) Mounting of auxiliary switches and alarm switches is possible.
- (d) Resistant to lightning impulse, surge and noise, and free from misoperation.
- (e) Mounting to IEC 35mm rails, can also be made through additional parts.

2.3 Compatibility with related equipment and perfectioning of accessory equipment

(1) 4 pole FAB

Together with diffusion of 3-phase 4-wire low voltage distribution system, use of 4 pole FAB is increasing, and diffusion of equipment using electronic parts, as such is the general trends, we have carried out the following improvement on 4 pole FAB from 50A frame to 1,200A frame:

- (a) Modularization of current 2 pole and 3 pole products.
- (b) Prevention of unbalanced voltage during opening and closing, by designed quick closing and delayed breaking mechanism for voltage poles (R, S, and T phases) of neutral pole (N phase).
- (c) Expansion of field of application up to capacity of 1,500kVA for three-phase transformers.

(2) Draw-out type FAB

In response to the demand for improvement of maintainability of the installation with economicity, this time, we have effectuated improvement on truck drawing out devices from 400A frame to 1,200A frame. The modification is made according to specifications of JEM 1265 "Low-voltage metal-enclosed switchgear" by which manipulability and safety were improved.

2.4 Internationalization of specifications

The number of export of FAB's, both as single units and components of machine tools and plants is increasing every year. Fuji Electric has endeavored for improvement of products aiming at internationality of the products so that they can be adapted to IEC, BS, NEMA, etc. which are the principal standards overseas. In particular, for exporting to the United States, as demands for approval of UL Standard 489 are increasing, BU Series have, before other competitors, obtained UL authorization on 17 models of

the series from 100A to 1,200A. These models are produced by taking into consideration of compatibility with the structure of American switchgears.

3 UL APPROVED BU SERIES

3.1 Outline of UL

UL was founded in 1884 by William Henry Merrill with a view to testing products against the risks of electric and fire accidents for American insurance companies. And later, the Laboratories have come to conduct tests on materials, equipment, products, instruments, buildings and systems for the risks that may cause damage to lives and properties with support of the American Insurance Association, but now the Laboratories have no direct connection and are managed as an independent non-profit organization and are considered as one of the largest and the most authoritative safety testing organization.

The main missions of the UL, from the stand point of consumers, with an aim of protecting life and properties against the risks of equipment fire and electric shocks, are to:

- (1) Establish standards regarding safety,
- (2) Conduct tests on various products basing on the standards established.
- (3) Publish the test results to insurance companies, government organizations, associated entities, and general consumers.



3.2 UL indication

UL will conduct tests according to the principles mentioned above, and give an approval to successful products and publish the fact. The indication regarding the MCCB's consists, as shown in *Table 2*, of two methods, namely that of listing service and recognition service.

(1) Listing Service

This commonly called listing service aims at products and their parts manufactured to be safe whichever the conditions and methods they were to be used. In due consideration of the fact that general consumer may use the products, investigations and tests are conducted on the safety of use in a wide range. When the products pass the test successfully, "Listing Mark" will be given and the fact is published to public in a product-classified list (Green Book)

Table 2 Indication of UL approval

Indication of UL approval		Safety	Publishing method		
			Indication attached to product	Publishing by UL	
Listing	Circuit breaker main body and its accessories that can be fixed by a general consumer.	Unconditional safety	Listing mark 	Product classified list (Green Book)	White card
Recognition	Accessories that can be fixed by factories registered by UL.	Conditional safety	Recognition mark 	Registered parts list (Yellow Book)	Yellow card

by UL.

(2) Recognition Service

This aims mainly at parts and materials to be incorporated into end products at the factories of producers, and when the products pass the examination, they will be listed in "Registered Parts List" (Yellow Book).

3.3 Comparison of UL standards with other main standards

As for standards regarding MCCB, there are: IEC1571, the international standard, BS3871, 4571 and VDE 0660 in Europe, and in the United States, UL-489 and NEMA AB1. Among them, the main parts of JIS, IEC and UL are compared and listed in Table 3.

As for the type test items in each standards, there are, calibration tests, overload tests, temperature tests, endurance tests, dielectric voltage-withstand tests, and interrupting ability tests. They are common to all standards, but the big features can be seen in the test sequence and the contents of interrupting ability tests.

For IEC's type tests, an independent sample is used for a test on each item, but for UL and JIS, the same sample is obliged to undergo a series of type tests. This is one of the biggest difference between them.

The contents of the main test items are the following.

(1) Overload test

Taking an example of 225A frame, the number of closing and opening according to JIS and IEC, is defined as 25 operations of opening and closing of 6 times more of

rated current with rated voltage, however, as UL dictates to open and close 50 operations, that is two times more than the former case. Therefore, for the UL-approved products, it is necessary to take into consideration of contact volume and contact materials.

(2) Temperature test

As for temperature test, each standard defines the temperature rise at terminal, joint and external insulated parts. For temperature tests on MCCB's, as listed in Table 3, IEC establishes 70 deg. while JIS and UL, 50 deg. for terminal parts which are the most important parts in MCCB's. In particular, the limit of temperature rise for UL, if we consider the fact that the overload opening and closing times are the double of those established by JIS, can be said to be a very strict limit.

(3) Interrupting ability test

UL and JIS specify single pole short circuit tests, but IEC does not specify it and imposes only three-phase short circuit tests.

Single pole short circuit test of JIS, as shown in Fig. 1, supposes the one-line ground fault, and with voltage of 265V at neutral point, the test current will be limited to 5kA, while, as shown in Fig. 2, UL supposes short circuit accident between different phases, and the tests are conducted under the circuit conditions of rated current of 8,660A with rated voltage. In case of three-phase short circuit test, as in case of IEC, a separate sample will be used for rated interrupting capacity test.

Table 3 Comparative list of main parts of standards

Test Item		UL 489	JIS C 8370	IEC 157-1
① Calibration test		① 100% <i>I_n</i> : No tripping 135% <i>I_n</i> : Tripping within 120 min. 200% <i>I_n</i> : Tripping within 10 min. (40°C)	① 100% <i>I_n</i> : No tripping 125% <i>I_n</i> : Tripping within 120 min. 200% <i>I_n</i> : Tripping within 8 min. (40°C)	① 105% <i>I_n</i> : No tripping for 120 min. 125% <i>I_n</i> : Tripping within 120 min. (20°C or 40°C)
② Overload test		② 600% <i>I_n</i> : Closes 50 operations	② 600% <i>I_n</i> : Opening and closing 25 operations	② 600% <i>I_n</i> : Opening and closing 25 operations
③ Temperature test		③ Less than 50 deg.	③ 50 deg or less, 600A or less	③ 70 deg or less
④ Endurance test		④ 8,000 operations	④ 8,000 operations	④ 8,000 operations
⑤ Dielectric voltage withstand test		⑤ Not specified	⑤ 2 <i>E</i> + 1,000V, 1 min.	⑤ 2,500V, 1 min.
Interrupting ability test (In case of 3-pole breaker)	Single-pole test	⑥ • 8.7kA with rated voltage • "O-t-CO" at each pole (100% <i>E</i>)	⑥ • 265V, 5kA • "O-t-CO" at each pole (100% <i>E</i>)	Not specified
	Three-phase test	⑥ • "O" 10kA at 3φ (100% <i>E</i>)	⑥ • "O-t-CO" at 3φ *100% <i>E</i> , 100% IC)	⑥ • "O-t-CO" at 3φ *100% <i>E</i> , 100% IC) [3φ "O-t-CO-t-CO" (110% <i>E</i> , 100% IC)]
	Judgement	• Withstand voltage: 2 <i>E</i> + 1,000V, 1 min. • Tripping: 200% <i>I_n</i>	• Insulation resistance: 0.5mΩ or more • Withstand voltage: 2 <i>E</i> , 1 min. • Tripping: 250% <i>I_n</i>	• Withstand voltage: 2 <i>U_i</i> , 1 min. • Tripping: 250% <i>I_n</i>
		Confirmation of interrupting capacity to be expanded		• <i>I_n</i> must be applied without abnormal temperature rise (to the degree that no harm should be done to insulators)
	Judgement on three-phase test	After clearing the above tests, carry out with separate sample. • 3φ: "O-t-CO" (100% <i>E</i> , 100% IC) • Withstand voltage: 2 <i>E</i> , 1 min. • Tripping: 250% <i>I_n</i> • No burning of fuse		• There should no burning of fuses.

NOTE: *I_n*: Rated current *E*: Rated voltage *U_i*: Rated insulation voltage IC: Rated interrupting capacity

Fig. 1 Ground fault or neutral pole short circuit in three-phase circuit

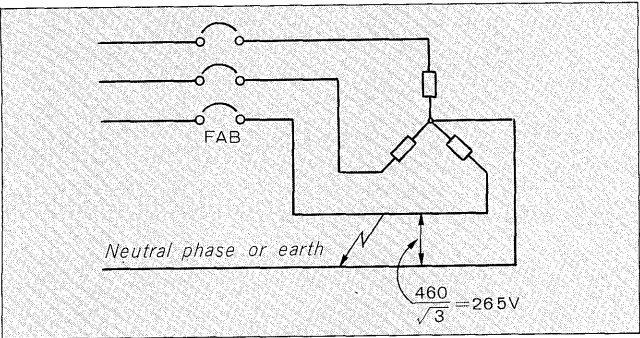
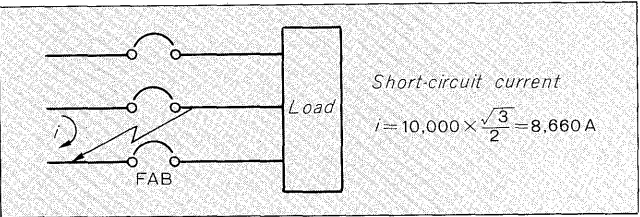


Fig. 2 Short circuit among different phases in shorted circuit in three-phase 10kA.

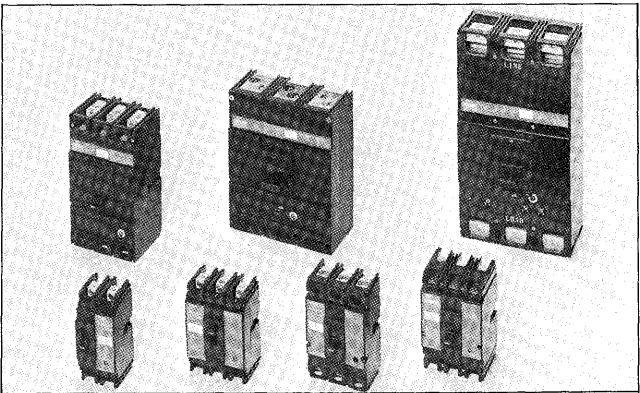


3.4 Composition and specifications of UL-approved BU series products

BU-series are composed of the following 17 models of 3 series. Specifications of each series are shown in Table 4 and their outer views, in Fig. 3.

- (1) General purpose lighting series: 100A to 400A Frames
- (2) Standard industrial series: 100A to 1,200A Frames
- (3) High interrupting rated series: 150A to 1,200A Frames

Fig. 3 BU series

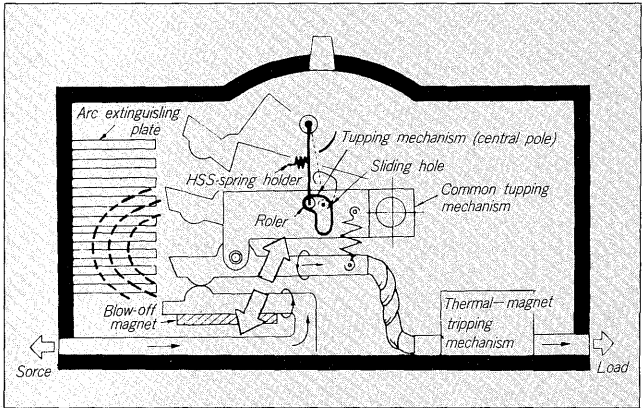


3.5 Features of UL-approved BU series

(1) HSS trip mechanism

The high interrupting rated series from 150A frame to 600A frame (BU-FHA – BU-LHA) adopt HSS (High Speed

Fig. 4 Construction of HSS mechanism



Simultaneous Trip Mechanism) and are provided with high speed interruption and high interruption capacity. By adopting series rated system, they are applicable to larger capacity installations with economicity.

The principle of operation, as shown in Fig. 4, is that the tripping mechanism is installed in the central pole and that they have a structure of opening rapidly all contactors simultaneously for all poles. The machines of this series are, unlike the conventional type of machines that have tripping mechanism at each pole, more compact and more effective for tripping larger current with higher speed. The operation are made in the following sequence.

- (a) When the short-circuit current flows, a repulsive magnetic force proportional to the square of the current running between each pole is generated.
- (b) The sum of this electromagnetic repulsion attaining to the predetermined value, the tripping mechanism mounted in the central pole enter into operation.
- (c) Then, all contactors open rapidly at the same time.
- (d) Consequently, the minimum current phase is interrupted steadily at the first phase.

When the three-phase short-circuit current is interrupted, if it is first-phase interrupted within a very short time, the subsequent second-phase and third-phase interruptions, as shown in Fig. 5, can be made by taking up the line voltage (E) by 2 series of contactors, so that the interruptions are made easier.

HSS mechanism, as shown in Fig. 6, by opening 3 poles at the same time, can interrupt the A phase receiving current zero point first with smaller arc energy. In order to

Fig. 5 Interruption of three-phase short-circuit circuit

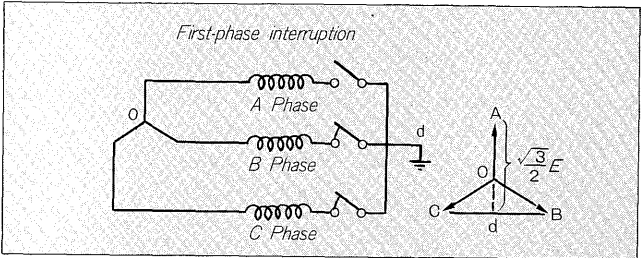
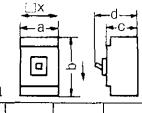


Table 4 List of specifications of BU series

Series	A Frame	Breaker type	No. of poles	Rated voltage (V) (UL489)		Rated current (A)	Rated interrupting capacity (kA·sym)										Outer dimen- sions (mm) X=35mm						Overcurrent tripping system
				AC	—																		
							240	480	250	125/ 250	220	380	500	660	250								
General purpose lighting	100	BU-ECA	2	240	DC	5 ~ 100	10	—	—	—	10	5	—	—	—	70	152	68	83	2X	Hydraulic magnetic type		
				—	125/ 250			—	—	5	—	—	—	—	5								
			3	240	—		10	—	—	—	10	5	—	—	—					105		3X	
	225	BU-GCA	2	240	—	125 ~ 225	10	—	—	—	10	10	—	—	10	105	172	68	87	3X	Thermal and magnetic type		
			3																				
		BU-GDA	2	240	—	125 ~ 225	22	—	—	—	22	14	—	—	10	105	172	68	87	3X			
			3																				
	400	BU-KDA	2	240	250	250 ~ 400	22	—	—	—	22	14	—	—	10	140	257	103	134	4X			
			3																				
	Standard industrial	100	BU-ESA	2	480	—	15 ~ 100	18	14	—	—	30	25	18	5	10	105	168	86	109	3X	Thermal and magnetic type	
3																							
150		BU-FSA	2	480	—	15 ~ 150	22	28	—	—	30	25	18	5	10	105	168	86	109	3X			
			3																				
250		BU-JSA	2	480	250	70 ~ 250	25	22	10	10	30	25	22	14	10	140	257	103	134	4X	Thermal and magnetic type		
			3																				
400		BU-KSA	2	480	250	125 ~ 400	42	30	10	10	65	30	25	14	10	140	257	103	134	4X			
			3																				
600	BU-LSA	2	480	250	250 ~ 600	42	30	10	10	65	42	25	18	10	210	273	103	139	6X				
		3																					
800	BU-MSA	2	480	—	600 ~ 800	42	30	—	—	65	42	25	18	—	210	400	105	158	6X				
		3																					
1,200	BU-NSA	2	480	—	1,000, 1,200	42	30	—	—	65	42	25	18	—	210	400	105	158	6X				
		3																					
High interrupting rated	150	BU-FHA	2	480	125/ 250	15 ~ 150	65	25	—	10	85	30	22	10	20	105	168	86	109	3X	Thermal and magnetic type		
			3																				
	250	BU-JHA	2	480	250	70 ~ 250	65	35	10	10	85	42	30	18	20	140	257	103	134	4X	Thermal and magnetic type		
			3																				
	400	BU-KHA	2	480	250	125 ~ 400	65	35	10	10	85	42	30	18	20	140	257	103	134	4X			
			3																				
	600	BU-LHA	2	480	250	250 ~ 600	65	35	10	10	85	42	30	22	20	210	273	103	139	6X			
3																							
800	BU-MHA	2	480	—	600 ~ 800	65	42	—	—	85	50	35	25	—	210	400	105	158	6X				
		3																					
1,200	BU-NHA	2	480	—	1,000, 1,200	65	42	—	—	85	50	35	25	—	210	400	105	158	6X				
		3																					

NOTE: The outer dimensions of 1,200A do not include those of block terminal.

avoid the risk of contact fusion in the vicinity of the critical current with which the tripping mechanism enters into operation, the contactors have a structure contactor pressure increases until immediately before pole opening together with the increase of the current. Further, the blow-off magnet shown in Fig. 7, applies magnetic drive to the arc on the contact surface and by moving it abruptly, a synergism for high-speed interruption can be obtained.

Fig. 8 shows the test oscillogram for Interrupting ability of BU-FHA (150A) Frame, 240V, 65kA (sym), and Table 5, comparison of interrupting ability test with that of

products of other marks, taking an example of 250A frame.

3.6 Back-up application

The circuit composition having a sufficient interrupting capacity with which all MCCB's installed in the circuit can cope with all interrupting ability that flows by their set position is called fully rated protection system. Recently, on account of economic consideration, a "series rated system" replacing the former system, is gaining more ground. Table 6 shows the application of compatible com-

Fig. 6 Waveform of Interrupting ability test

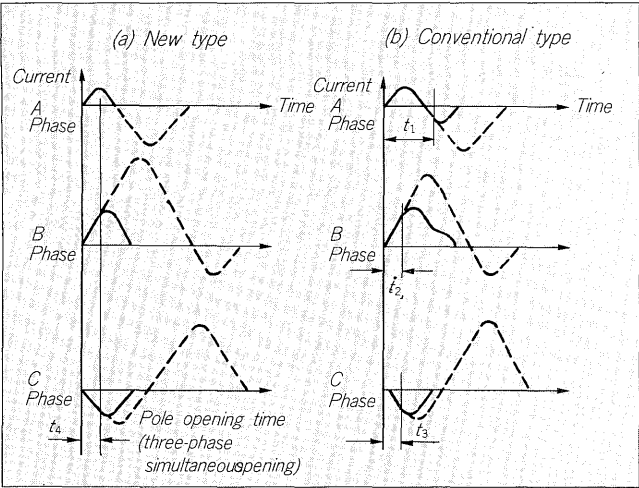


Fig. 8 Interrupting ability oscillogram of BU-FHA, 240, 65kA

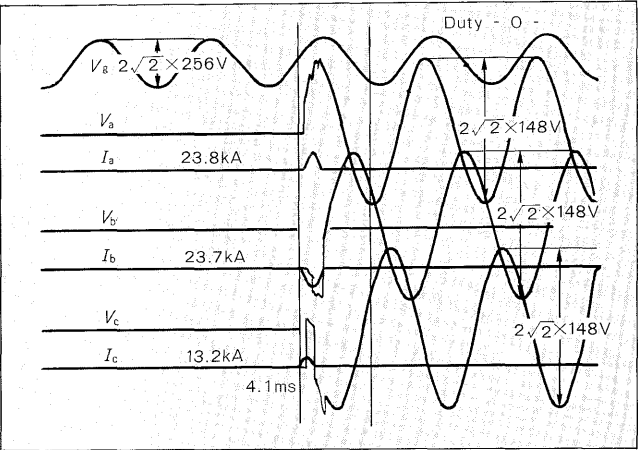


Fig. 7 Construction of blow-off magnet

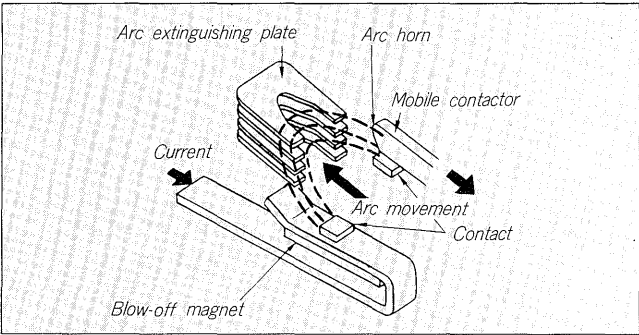


Table 5 Comparison of interrupting ability test

Machine types	Conditions	480V 35kA (sym)		
		Current peak (kA)	$i^2 t$ ($\times 10^6 \text{ A}^2 \text{ s}$)	Arc energy (kWs)
BU-JHA 250A Frame		35	7.5	47.5
250A Frame of Firm A (USA)		50	12.5	68.5
250A Frame of Firm B (USA)		52.5	14	73.5

Table 6 Application of compatible combination for series rated interruption

(a) AC240V (kA)

Back-up FAB				Back-up FAB						
Backed-up FAB				150		250		400		600
				BU-FSA	BU-FHA	BU-JSA	BU-JHA	BU-KSA	BU-KHA	BU-LHA
Frame (A)		Type	Type Interrupting rating (kA · Sym)	22	65	25	65	42	65	65
Backed-up FAB	100	BU-ECA	10	22	25	25	25	—	—	—
		BU-ESA	18	22	65	25	65	42	65	65
	150	BU-FSA	22	—	—	25	65	42	65	65
		BU-GCA	10	—	—	—	—	30	30	30
	225	BU-GDA	22	—	—	—	—	65	65	65
400	BU-KDA	22	—	—	—	—	—	—	—	65

(b) AC480V (kA)

Back-up FAB				Back-up FAB				
Backed-up FAB				250		400		600
				BU-JSA	BU-JHA	BU-KSA	BU-KHA	BU-LHA
Frame (A)		Type	Type Interrupting rating (kA · Sym)	22	35	30	35	35
Backed-up FAB	100	BU-ESA	14	22	35	30	35	35
		BU-FSA	18	22	35	10	35	35
	150	BU-FHA	25	—	35	30	35	35
		BU-JSA	22	—	—	30	35	35

The diagram illustrates a 3-phase busbar system with three different protection schemes. A transformer at the top provides a conventional short-circuit current of 65kA. The busbar is divided into three sections, each with a different protection scheme:

- Series rated system:** This section has a busbar with a rating of 600A and 65kA. It is protected by a circuit breaker (BU-FSA) with a rating of 150A and 22kA. The busbar is connected to a busbar with a rating of 100A and 18kA, which is then connected to a busbar with a rating of 225A and 22kA.
- Fully rated system:** This section has a busbar with a rating of 600A and 65kA. It is protected by a circuit breaker (BU-FHA) with a rating of 150A and 65kA. The busbar is connected to a busbar with a rating of 250A and 65kA.
- Series and fully rated system:** This section has a busbar with a rating of 600A and 65kA. It is protected by a circuit breaker (BU-EHA) with a rating of 100A and 18kA. The busbar is connected to a busbar with a rating of 150A and 65kA.

The diagram also shows a "Series rated cooperation" system where the busbar is connected to a busbar with a rating of 400A and 65kA, which is then connected to a busbar with a rating of 150A and 18kA.

3.7 Search for ease of use

Fig. 10 Distribution panelboard

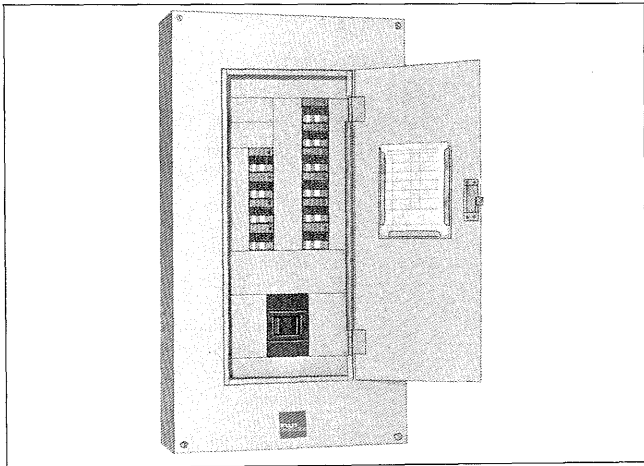


Diagram illustrating a 3x3 grid of cells. The grid is composed of 9 cells, each measuring $4X$ by $6X$. A 3x3 bar link is shown, with dimensions $3X$ and $4X$ indicated. The bar link is labeled "3x3 bar link".

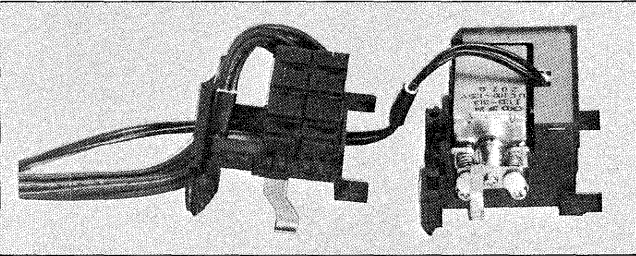
- (1) Size of width of FAB is shown in *Fig. 11* and *Fig. 12*. The module and panel cut width sizes are unified to 102mm. By this unification, mounting of MCCB to main bus bar shown in *Fig. 12* can be made easier. Further, by preparing branching conductor (See *Fig. 13*) for exclusive use for connecting cable terminal with main bar, a consideration is made to facilitate the mounting of MCCB's.
- (2) The terminals of BU Series have all passed successfully the secureness test, drawing test and heat cycle test established in UL 486 (Wire Connector) and approved by it. Block terminals (See *Fig. 14*) are adopted that can be connected, naturally, to copper cables, but also to aluminum cables.
- (3) For breakers above 600A frames, "interchangeable trip

The diagram illustrates a bus bar assembly with a central vertical bus bar and a horizontal bus bar link at the bottom. The assembly is divided into four sections by horizontal lines. The sections are labeled with bus bar sizes and spacings:

- Top section: 3X, 100, 150AF
- Second section: 3X, 225AF
- Third section: 4X, 250, 400AF
- Bottom section: 6X, 600-1,200AF

Labels on the left side of the diagram include: Bus bar, 1X, 1X, 1X, 1X, 1 1/2 X, 1X, 1X, 2X, 2X, 2X, and Bus bar link.

Fig. 15 Cassette type accessories to inner mechanism



unit” that can be replaced by users alone by trip units, is adopted so that flexible coping as compression of stocks can be made. Also, the accessory devices of inner mechanism (auxiliary switches, alarm switches, shunt trip devices, undervoltage release devices) are of cassette structure that can be mounted on part of users, and the both products are approved by UL as “listing”.

Also as for devices accessory to inner mechanism of 100A to 400A frames, they are UL-approved products as “recognition” that can be mounted in the places (factories and service centers) designated by UL.

3.8 Quality control and UL follow-up service

UL conducts tests and gives approval to the products that have passed its examination, then publishes the fact. The approved products (listing) are inspected and examined by manufacture lot by UL Follow-up Service, and those that have passed the test will be dispatched. As shown in Table 7, periodical inspection and test are compulsory according to the frame size of the products. Also, as for the test facilities, besides the manufacturers’ autonomous inspection, periodical inspections are obliged to carry out, so that the quality is assessed from a global view point.

Table 7 Contents of follow-up service periodical inspection

Frame Inspection period Inspection Item	Case of 150A Frame		Case of 225A Frame
	Quarterly	Semiannually	Annually
1. Calibration test	○		○
2. Overload test	○		○
3. Temperature rise test	○		○
4. Endurance test	○		○
5. Calibration test	○		○
6. Dielectriv voltage withstand	○		○
7. Interrupting ability test		○	○
8. Calibration test		○	○
9. Dielectric voltage withstand		○	○

4 SUMMARY

We have introduced the outline of ratings and specifications as well as their features of BU series, a new Fuji Auto-Breaker series that have obtained approval from UL, passing the examinations established in UL Standards. Our main objectives of FAB development and improvement, this time, have been the possibility of contributing to total cost down on part of our users, stressing on the economicity of the products. Since, in recent years, the export is active, in particular, the export of plant and machine tools to industrialized countries, beginning with the United States and other countries, and as the demand for FAB, together with building of factories at site is increasing, we have positively propelled our policy of obtaining UL approval. However, the market demands are variegated and diversified, so that we are determined to develop and improve still further FAB’s in a form that all of these demands are included therein. We appreciate most ever constant understanding and support from our Customers.