YASKAWA

Date: ___/___/___

Attention: ______________________
Company Name: ______________________
Address: ______________________
City, State, Zip: ______________________
Phone: ______________________

Product Information for Bestact Large-Capacity Type Switches (R14 / R15)

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Switch Business Unit

Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

Table of Contents

Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

Table of Contents

Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

1. Outline Drawing

Dimensions (mm)

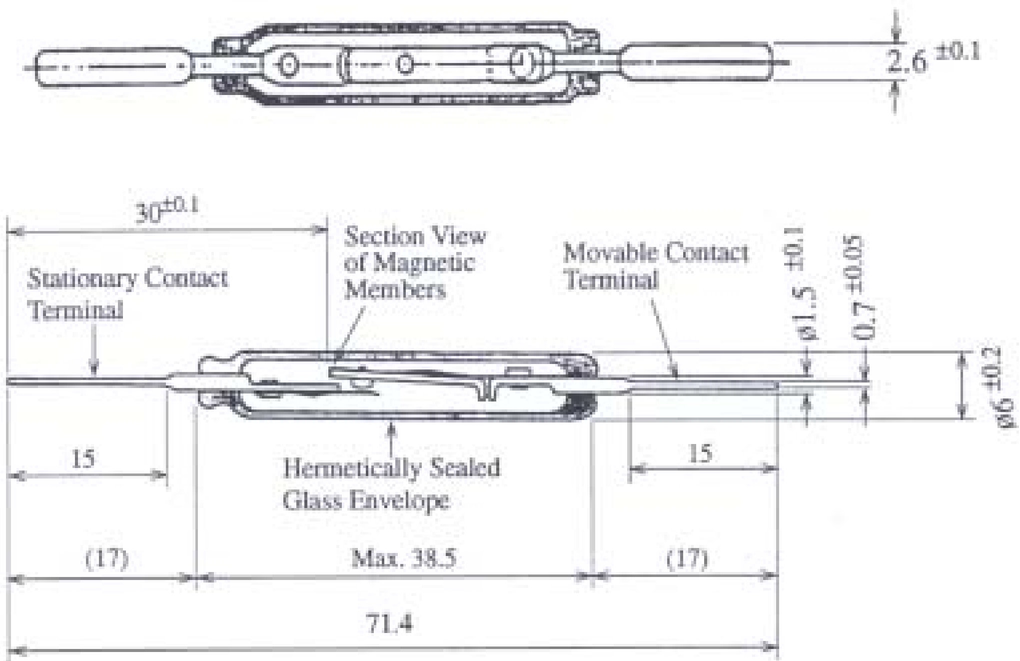


Fig. 1 Construction and Dimensions of Bestact Switch

Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

2. Ratings and Specifications

Application			For General Purpose	For Heavy Duty	Remarks
Type			R14	R15	
Contact Arrangement			1a		—
Contact Performance	Rating Continuous Current		5 A		—
	Rating Operational Current *1	AC	200 V 1 A		Inductive load
		DC	110 V 0.5A, 220V 0.2A		Inductive load (Time Constant (L/R), τ = 100 ms)
	Max. Making Current*2		220 VAC 30 A		Power factor 0.7
	Max. Breaking Current*3		220 VAC 30 A		Power factor 0.4
			110 VDC 0.6 A 220 VDC 0.4 A	110 VDC 0.6 A 220 VDC 0.4 A	Time Constant τ = 100 ms
	Min. Operating Power Ratings		1 V 1mA	24 V 10mA	—
	Withstand Voltage Across Contacts		800 VAC 1 minute		—
	Insulation Resistance		10^9 Ω or greater		With 500 VDC megger
	Initial Contact Resistance		100 mΩ or less	500 mΩ or less	6 VDC 1 A
Operating Characteristics	Pickup Ampere-Turns		180 – 230 AT		Yaskawa standard coil is 3000 turns, 33.5 mm long, 10.5 mm I.D. with 0.2 mm dia. wire
	Dropout Ampere-Turns		60 AT or greater		
	Operation Time		4 ms or less (excluding bounce)		At 150% of pickup ampere-turns using standard coil
	Releasing Time		2 ms or less*4		
Mechanical Life			50,000,000 operations	Over 100,000,000 operations	—
Mechanical Performance	Vibration Resistance		20 G or greater		20 – 1000 Hz
	Impact Resistance		40 G or greater (100 G or greater)		Value in ( ) indicates breakdown G
	Terminal Drawing Force		22.05 lb (10 kg)		—

Note: *1. Where 220 VAC, the rated operational current is set at 10 times this value upon making (PF: 0.6 – 0.7) and 1 time this value upon breaking (PF: 0.3 – 0.4). Rated operational current 1 A means 10 A making and 1 A breaking. Where 110 VDC is indicated, the current is set at 1 time closing and 1 time breaking.

*2 The maximum making current complies with JIS C 4531, and enables 100 times making at a power factor of PF: 0.7.

*3 The maximum breaking current, by referring JIS C 4531, is based on switching 25 times at PF: 0.4. Time constant, τ = 100 ms in either of 110 VDC or 220 VDC cases.

*4 The breaking time indicates the value when the coil is equipped with a flywheel diode.

3. Contact Characteristics

3.1 Contact Resistance Distribution (including any specific lead resistance)

Measuring conditions: Excite by 150% of the switch's pickup ampere-turns using standard coil and flow a current of 1 A at 6 VDC through the contacts. Measure contact resistance by the four-terminal method (Fig. 2).

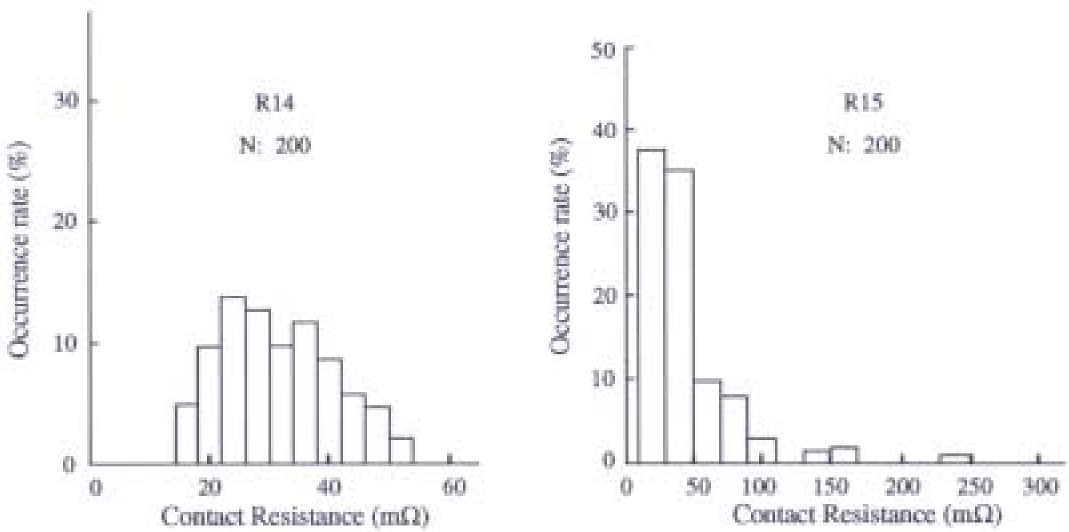


Fig. 2 Contact Resistance Distribution

3.2 Operational Current and Temperature Rise (measured at terminals)

When actuating the switch by electromagnetic coil, radiative heat transfer to the switch can occur. Therefore, the contacts are closed by a permanent magnet and the temperature rise (at terminal leads) is measured to find the relationship with operational currents (Fig. 3).

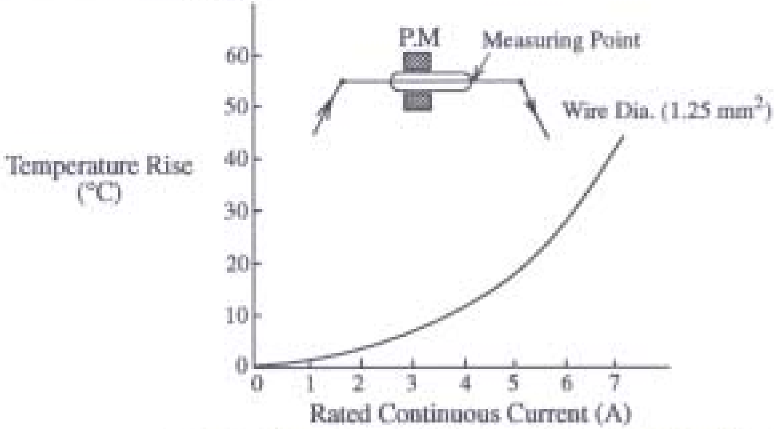


Fig. 3 Operational Current and Temperature Rise

Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

3. 3 Making Current Capacity (according to Japanese Electrical Manufacturers JEM 230)

Test Conditions

Voltage and Current : 250 VAC, 30 A (Power factor cosφ = 0.7)

Operation Duty : Make an open circuit (no current breaking of test units) immediately after opening a closed circuit and hold this condition for 10 sec. Repeat this operation 100 times.

Contacting : Excite by 150% of the switch's pickup ampere-turns (using standard coil)

No. of Tested Units : 30 units

Test Results

No defects of any of the samples were found.

3. 4 Breaking Current Capacity

Test Conditions

The test was conducted with the following conditions, according to JEM 230.

Class	Test Voltage	Test Current		Power Factor (cosφ) Time Constant (L /R) ms	Applications
		Making current	Breaking current		
AC 11	250 V	30 A	30 A	0.6 ~ 0.7	For AC magnetic contactor operation
DC 11	110 V	0.6 A (1 A)*	0.6 A (1 A)	100 ms	For DC magnetic contactor operation

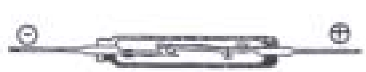
Operation Duty : 25 close-open operations with 10 seconds intermittence

Contacting : Excite by 150% of the switch's pickup ampere-turns (using standard coil)

No. of Tested Units : 10 units for the AC 11 class
10 units for the DC 11 class

For the DC load only

*: The above mentioned value is the value when the movable contact is connected to the positive polarity.



Test Results

No defects of any of the samples were found.

Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

3.5 Limit of Making Circuit Current

Measurement is performed to find the relationship of the switch's pickup ampere-turns and the limit of the making current, according to JEM 230 (Fig. 4).

Test Conditions

Voltage and Power Factor :		250 VAC, power factor ($\cos\varphi = 0.7$)
Operating Duty	:	100 times of only making circuit for each current value with 10 seconds intermittence
Contacting:	:	Excite by 150% of the switch pickup ampere-turns (using standard coil)

Test Result

Figure 4 shows the test results which indicate the greater the switch's pickup ampere-turns are, the greater the making current can be. Switches with pickup ampere-turns 180 or more have making current limit values of 60 A or greater. Selection of a switch with pickup ampere-turns as large as possible is recommended for applications requiring a large making current.

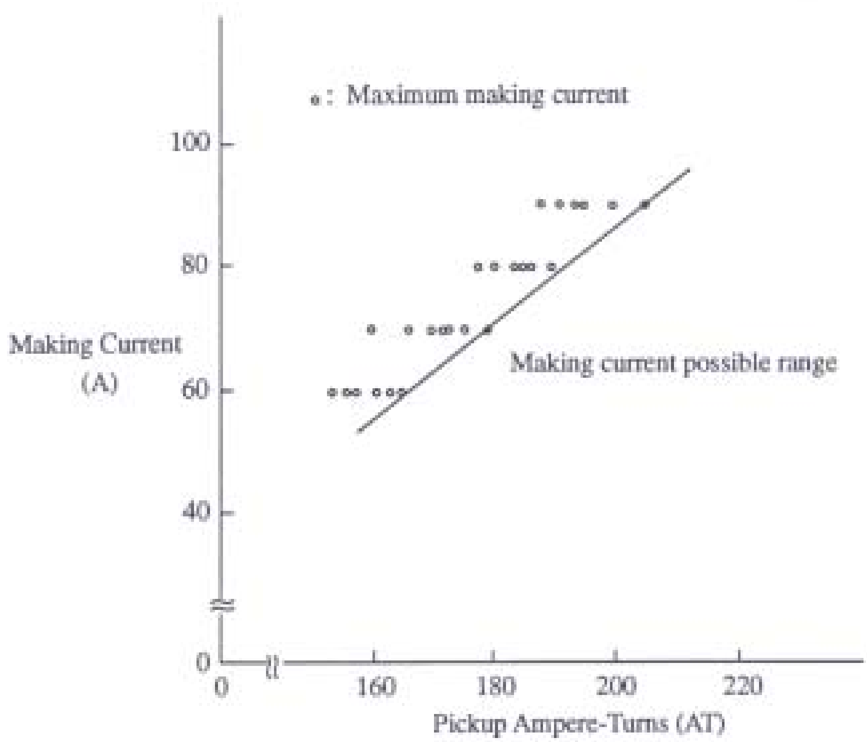


Fig. 4 Making Current of Switch

Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

4. Insulation Characteristics

4.1 Withstand Voltage Across Contacts

A breakdown voltage is measured by repeatedly impressing a voltage with a commercial frequency of 60Hz at the terminal leads of the open contact at 20°C ambient and relative humidity 60% and holding this condition for one minute each time (Fig. 5).

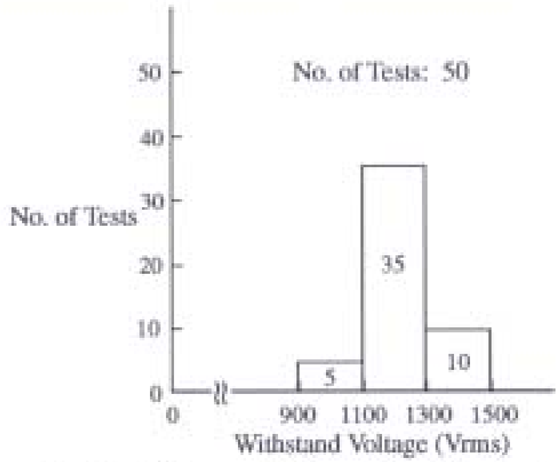


Fig. 5 Withstand Voltage Distribution Across Contacts

4.2 Insulation Resistance Across Terminals

After thoroughly cleaning and removing any dirt, grease, etc., on the surface of the glass; insulation resistance is measured by impressing 500 VDC at the terminal leads of the open contact at 20°C ambient and a relative humidity of 60%. An insulative resistance meter (megohmeter) is used for this measurement (Fig. 6).

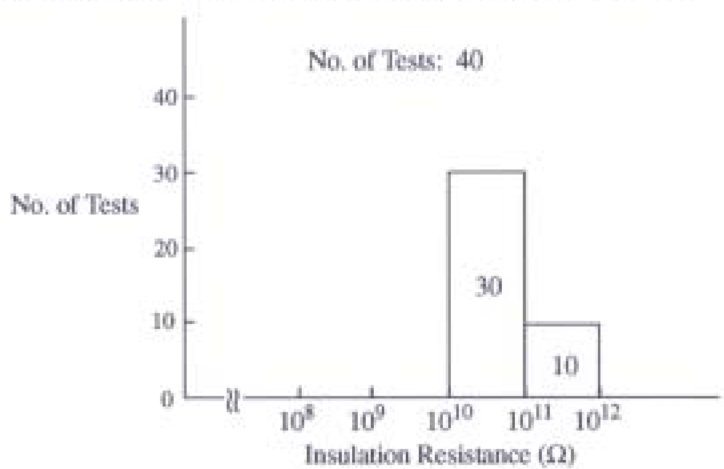


Fig. 6 Insulation Resistance Distribution Across Terminals

Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

5. Environmental Characteristics

5.1 Temperature Characteristics of Pickup and Dropout Ampere-Turns

In general, pickup and dropout ampere-turns of the reed switch can vary because of ambient temperature. With Bestact, its pickup ampere-turns show a tendency to decrease because of the modulus of elasticity of the flat spring when the temperature rises. In addition, its dropout ampere-turns show a similar tendency. However, this is smaller than that which is seen with the pickup ampere-turns value.

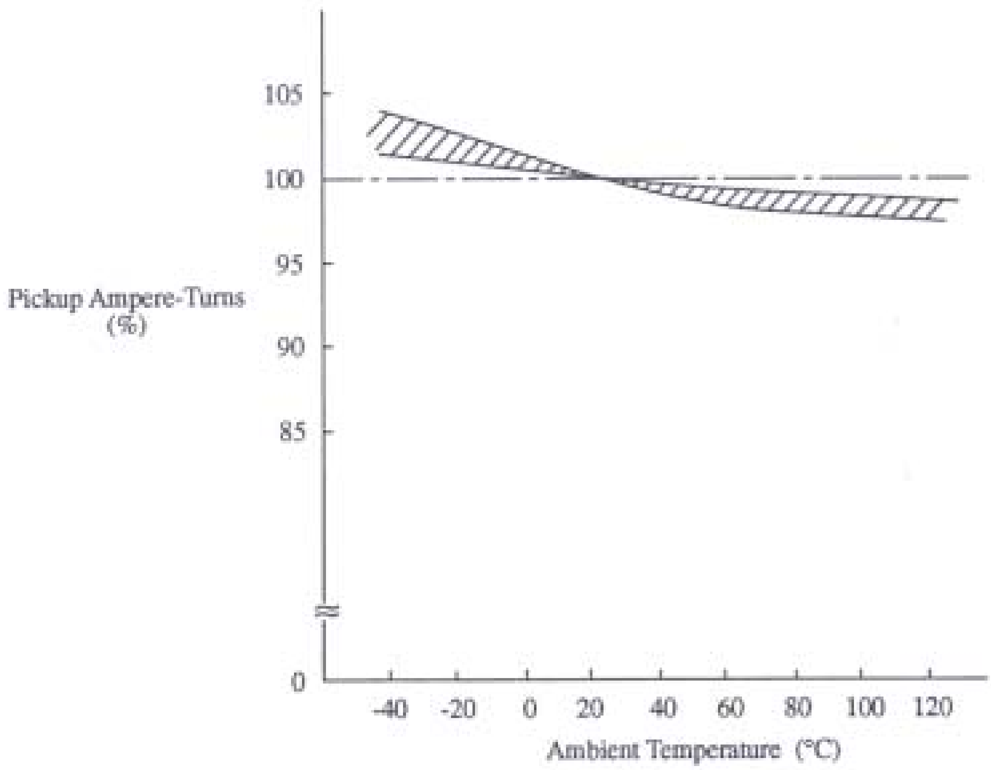


Fig. 7 Ambient Temperature Characteristics of Pickup Ampere-Turns

5.2 Creep Characteristics at High Temperature

When a reed switch is used at high ambient temperature for a long period of time, its pickup and dropout ampere-turns decrease because of creep, that is, "relaxation" caused in the spring material. Bestact uses a flat spring which is subject to static stress plus an alternate stress. These stresses can produce two types of creep, that is, "static creep" which occurs when the contact is in the 'on' condition for a long period of time and "dynamic creep" which occurs in repeated 'on-off' condition. However, Bestact has a structure which reduces dynamic creep to a negligible amount compared to static creep. Therefore, the decrease of its pickup and dropout ampere-turns because of static creep should only be considered. Fig. 8 shows the decrease of pickup ampere-turns due to static creep. The diagram shows the small change of pickup ampere-turns because of static creep as long as the reed switch is used in temperatures of 120°C or less. In addition, dropout ampere-turns decrease similarly and the amount of change is almost the same as that seen below.

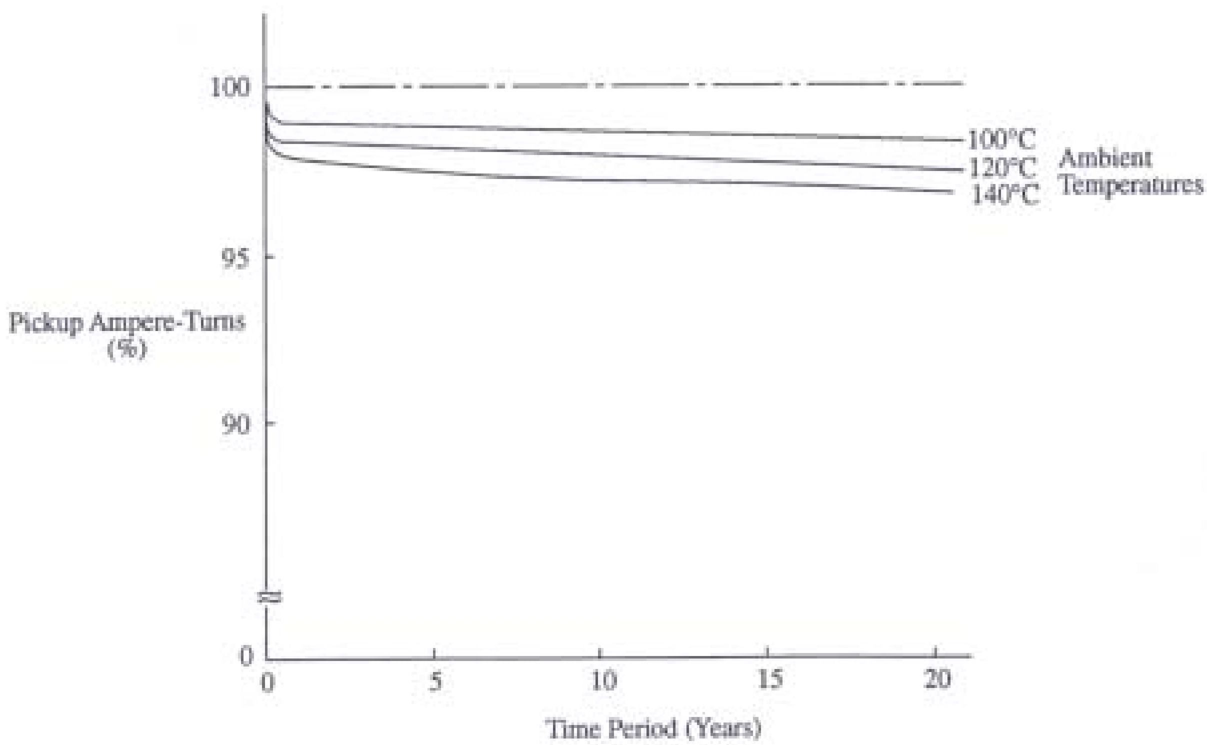


Fig. 8 Changes of Pickup Ampere-Turns

Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

5.3 High and Low Temperature Effect Tests

Where reed switches are stored and left as they are for a long period, there are no time-dependent characteristic changes at all except in special environments. Yaskawa Electric performs measurements of the changes of pickup and dropout ampere-turns, making time, breaking time and contact resistance after leaving reed switches in isothermal vessels at -60°C and 200°C. The contacts were left open and left closed for 50 hours. Results of these tests indicate that the pickup ampere-turns of the closed contacts decreased (about 2.5%), however, all other characteristics were very close to normal.

a. High Temperature Effect Test

Changes of pickup and dropout ampere-turns were measured after the contacts were placed in isothermal vessel at 200°C where the contacts were left open as well as closed for 50 hours. (Fig. 9).

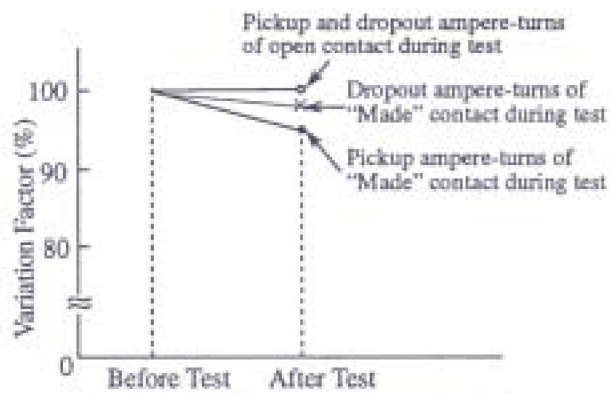


Fig. 9 High Temperature Immersion Test

b. Low Temperature Effect Test

Figure 10 shows the change of pickup and dropout ampere-turns after the contacts were placed in vessels at -60°C for 50 hours. There were no significant differences seen between the open contacts and closed contacts.

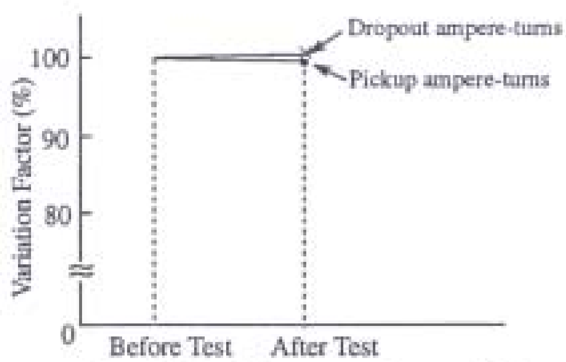


Fig. 10 Low Temperature Immersion Test

5.4 Heat Cycle Test (according to MIL-STD-202D)

Characteristic changes were measured before and after cycling the contacts in isothermal vessels at -65°C and 200°C. There were no glass cracks observed and almost no characteristic changes after the test (Fig. 11 and 12).

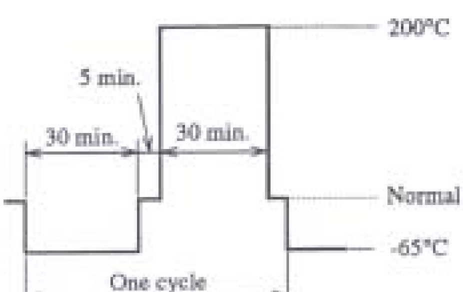


Fig. 12 Heat Cycle Test

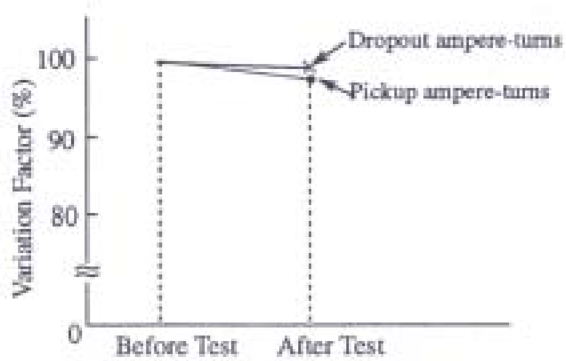


Fig. 11 Heat Cycle Test

Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

5.5 Terminal Lead Soft Solder Immersion Test

Characteristic changes are measured after immersing terminal leads (3 mm from the glass seal) in soft solder baths at 260±5°C for 5 seconds. There were no glass cracks observed and almost no characteristic changes seen after the test (Fig. 13).

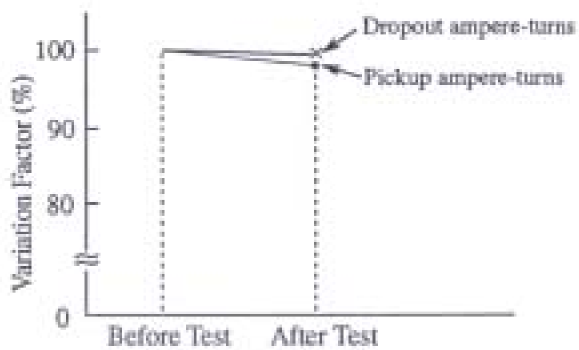


Fig. 13 Terminal Lead Soft Solder Immersion Test

5.6 Vibration Resistance Test (resonant frequency and malfunction range)

Test Conditions

- Frequency : 20 ~ 1000 Hz
- Vibration Direction : As shown in Fig. 14

Malfunction criterion (Test method 310 of MIL-STD-202E)

- Contact chattering time: 10 µ sec. or greater

Test Result

Figure 14 shows the relationship of vibration frequency and malfunction acceleration. The vibration resistance depends on the direction of vibration and contact action, as well as whether the contacts are opened or closed. It is weakest when the direction of contact action and vibration coincide in any case.

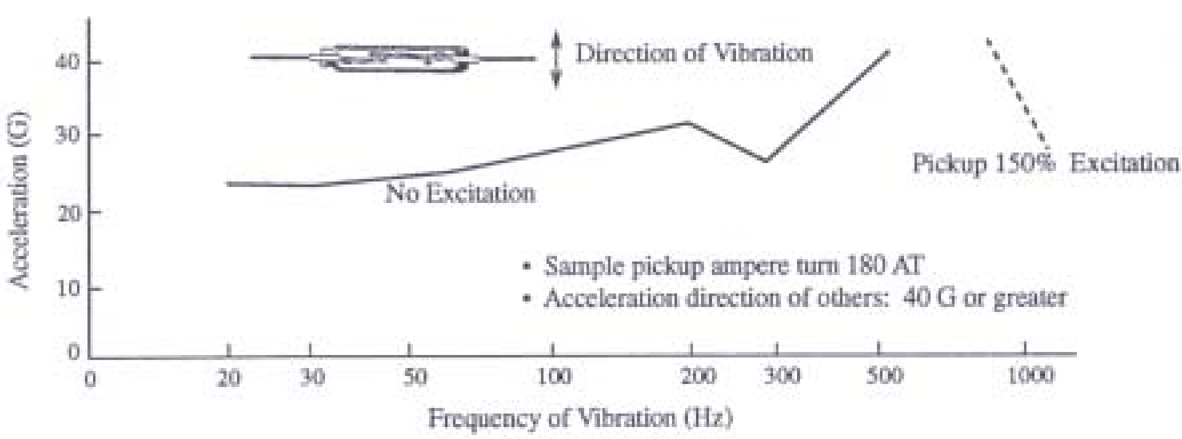


Fig. 14 Vibration Resistance Test

5.7 **Impact Resistance Test** (Malfunction test)

<u>Test Conditions</u> (Test method 213B of MIL-STD-202E)

- Free fall impact test
- Impact time: 11 ms

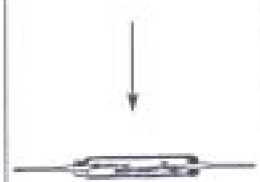
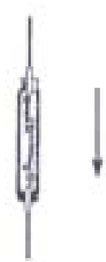
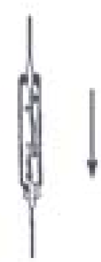
<u>Malfunction Criterion</u> (Test method 310 of MIL-STD-202E)

- Contact chattering time 10 μ sec. or greater

<u>Test Results</u>

The impact resistance depends on the direction of contact action and impact, as well as whether the contacts are opened or closed. It becomes weakest when the direction of contact action and impact coincide in any case. The minimum impact resistance (with open contacts) is 40 G in this case. For details, see the following:

Impact Resistance Test

Direction of Impact				
No Excitation	40 G	100 G or greater	80 G	100 G or greater
150% Excitation	100 G or greater (90 G)*	100 G or greater (60 G)*	100 G or greater	100 G or greater

* ( ) shows the value at 110% excitation of pickup ampere turn.

Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

6. Electrical Life and Contact Reliability

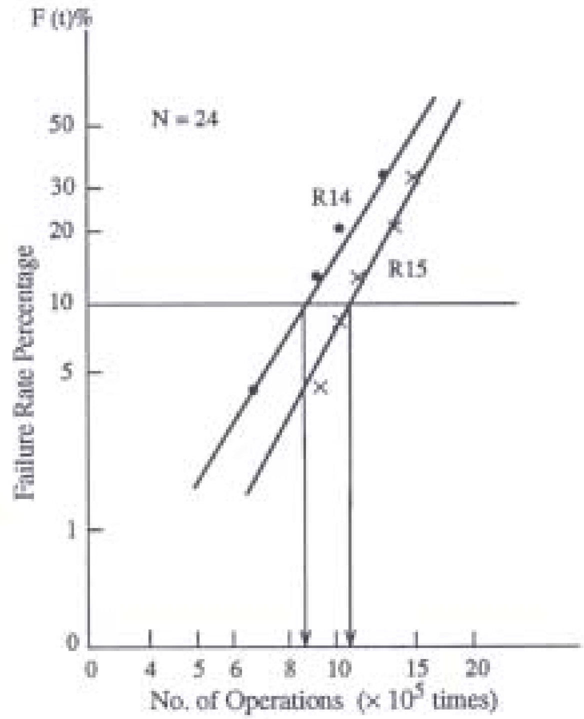
6.1 220 VAC 10 A Making Current (p.f = 0.7) 1 A Breaking Current (p.f = 0.4)

Test Conditions

- Frequency of making and breaking current: 3600 times / hour
- Arc protective circuitry: None
- Determination of fault: Check every time for open and close fault (Mis-contact, contact weld, etc.)
- No. of tested units: N = 24

Test Results

- Fault occurs only during breaking
- 90% reliability life
  R14: 860,000 operations
  R15: 1,050,000 operations



6.2 100 VDC 0.5 A Inductive Load

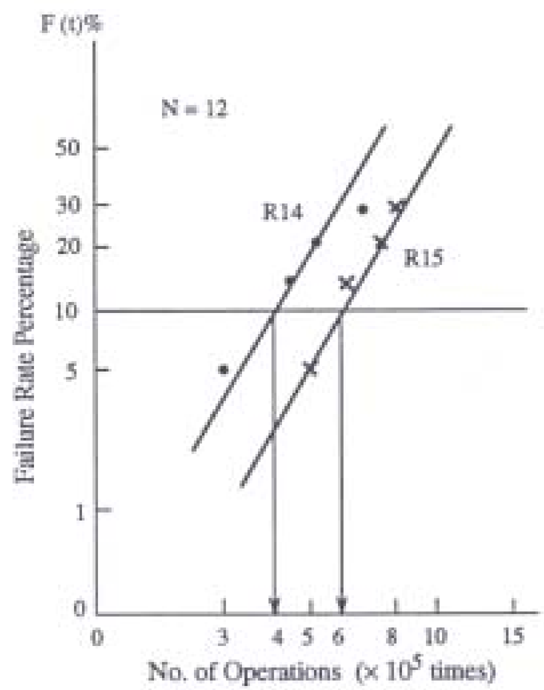
(Time constant τ = 100 ms)

Test Conditions

- Frequency of making and breaking current: 1800 times / hour
- Arc protective circuitry: None
- Stationary terminal connected to anode (+)
- Determination of fault: check every time for open and close fault (Mis-contact, contact weld, etc.)
- No. of tested units: N = 12

Test Results

- Fault occurs only during breaking
- 90% reliability life
  R14: 420,000 operations
  R15: 580,000 operations



Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

6.3 100 VDC 0.5 A Resistive load

Test Conditions

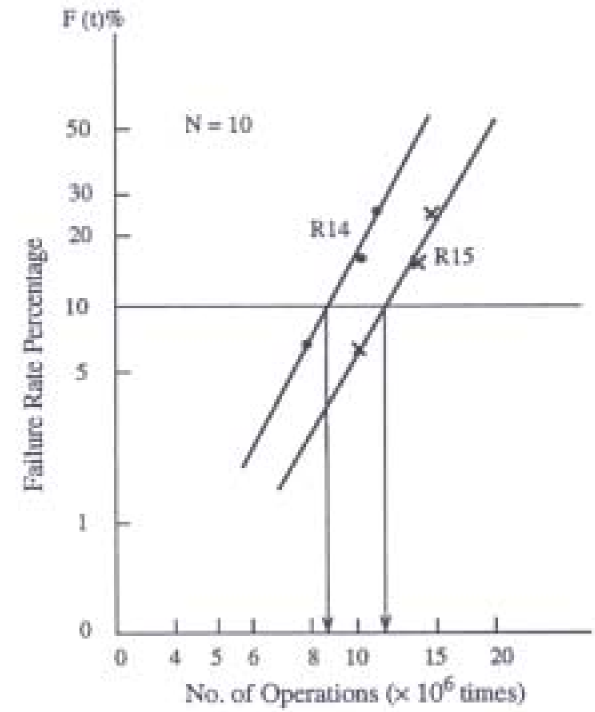
- Frequency of making and breaking current: 7200 times / hour
- Arc protective circuitry: None
- Stationary terminal connected to anode (+)
- Determination of fault: Check every time for open and close fault (Mis-contact, contact weld, etc.)
- No. of tested units: N = 10

Test Results

- Fault occurs only during breaking
- 90% reliability life

  R14: 8,500,000 operations

  R15: 11,500,000 operations



6.4 100 VDC 0.06 A Relay Coil Load

(Time constant τ = 22 ms)

Test Conditions

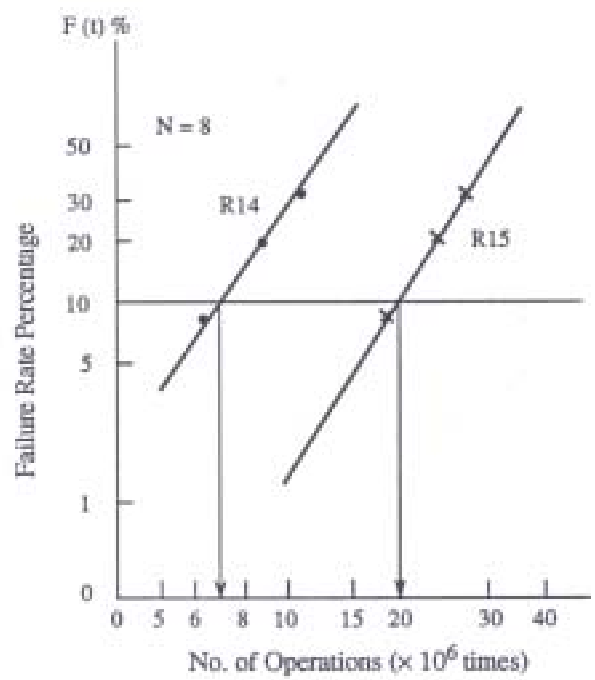
- Making / breaking frequency: 8 Hz
- Arc protective circuitry: None
- Stationary terminal connected to anode (+)
- Determination of fault: Check every time for open and close fault (Mis-contact, contact weld, etc.)
- No. of tested units: N = 8

Test Results

- Fault occurs only during breaking
- 90% reliability life

  R14: 7,200,000 operations

  R15: 19,000,000 operations



Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

6.5 5 VDC 1 mA Resistive load

Test Item (Switch): R14

Test Conditions

- Making / breaking frequency: 10Hz
- No. of operations: 5,000,000 operations
- Stationary terminal connected to anode (+)
- No. of tested units: N = 200

Determination of Fault

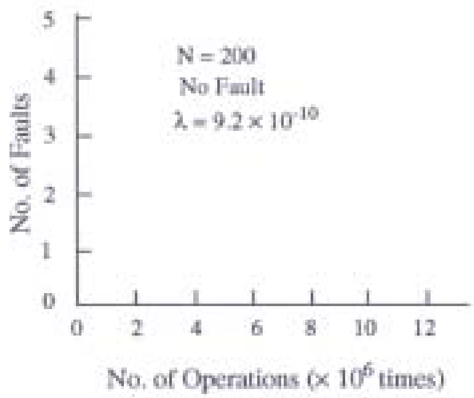
- Check every time for open and close fault
- Level of check

  Open fault: 4.5 V (90% test voltage) or less across contacts

  Close fault: 50 mV or greater across contacts

Test Results

- No fault
- Failure rate: $\lambda = 9.2 \times 10^{-10}$



6.6 1 VDC 1 mA Resistive Load

Test item (Switch): R14

Test Conditions

- Making / breaking frequency: 10Hz
- No. of operations: 5,000,000 operations
- Stationary terminal connected to anode (+)
- No. of tested units: N = 40

Determination of Fault

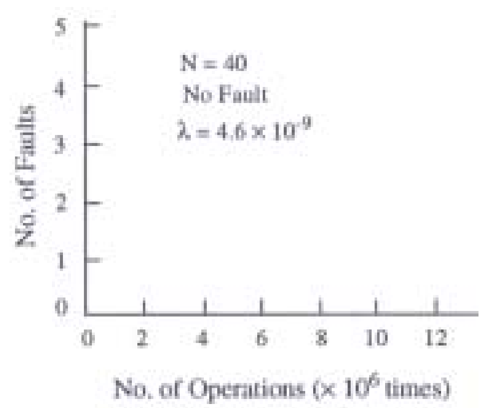
- Check every time for open and close fault
- Level of check

  Open fault: 0.9 V (90% test voltage) or less across contacts

  Close fault: 50 mV or greater across contacts

Test Results

- No fault
- Failure rate: $\lambda = 4.6 \times 10^{-9}$



6.7 24 VDC 10 mA Resistive load

Test Item (Switch): R15

Test Conditions

- Making / breaking frequency: 10 Hz
- No. of operations: 10,000,000 operations
- Stationary terminal connected to anode (+)
- No. of tested units: N = 100

Determination of Fault

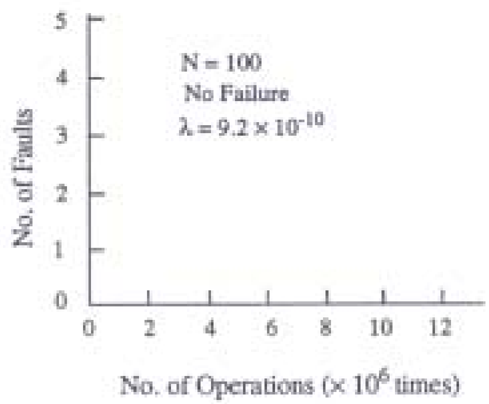
- Check every time for open and close fault
- Level of check

  Open fault: 21.6 V (90% test voltage) or less across contacts

  Close fault: 1.2 V (5% test voltage) or greater across contacts

Test Results

- No fault
- Failure rate: $\lambda = 9.2 \times 10^{-10}$



6.8 20 VDC 7 mA Resistive Load

Test item (Switch): R15

Test Conditions

- Making / breaking frequency: 10 Hz
- No. of operations and No. of tested units:

  15,000,000 operations / 30 units

  12,000,000 operations / 20 units
- Stationary terminal connected to anode (+)

Determination of Fault

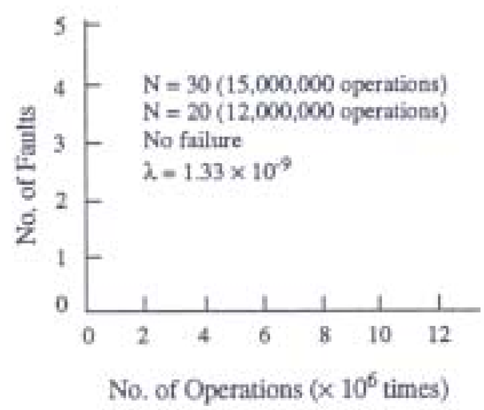
- Check every time for open and close fault
- Level of check

  Open fault: 18 V (90% test voltage) or less across contacts

  Close fault: 1.0 V (5% tested voltage) or greater across contacts

Test Results

- No fault
- Failure rate: $\lambda = 1.33 \times 10^{-9}$



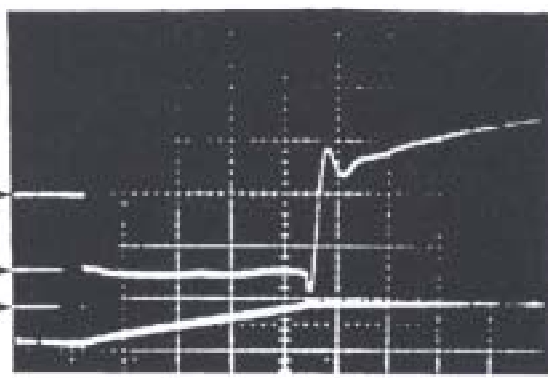
7. Surge Voltage Characteristics

7.1 AC Inductive Load Breaking

Test Item \ Load 220 VAC 60 Hz		Surge Voltage (V) Yaskawa's Contactors HI - 12E	HI - 35E	HI - 125E
Bestact Switch		500	450	500
Power Relay	Company A	1500 ~ 2000	1000 ~ 1200	800 ~ 1000
	Company B	1700 ~ 2000	1000 ~ 1500	800 ~ 1200

Breaking Waveform

Bestact Switch



Power Relay

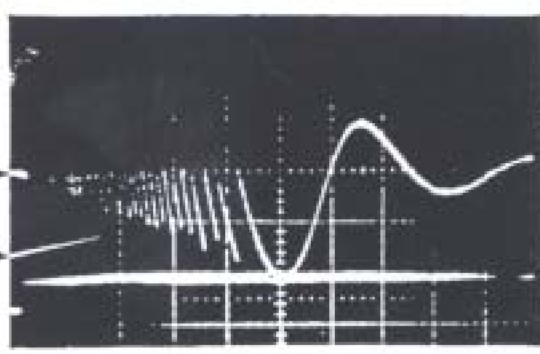


Fig. 15 Breaking Waveform for AC Inductive Load

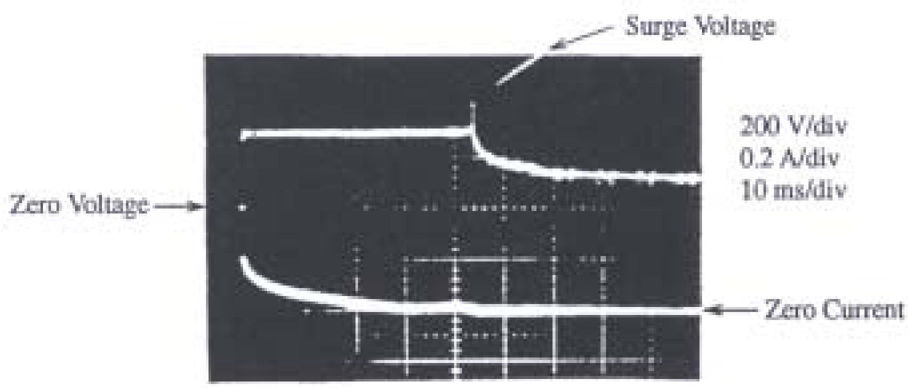
7.2 DC Inductive Load Breaking

Test Item \ Load 100 VDC		Surge Voltage (V)			
		Valve Load	Relay Load		
		i = 0.2 A τ = 130 ms	Company A *1	Company B *2	Yaskawa RAP - 6G
Bestact Switch		400 ~ 500	400 ~ 550	500 ~ 600	500 ~ 600
Power Relay	Company A (Magnetic Blowout Type)	3000 ~ 4000	1000 ~ 1200	1400 ~ 1600	1600 ~ 1800
	Company B (Standard Type)	Unstable breaking	1000 ~ 1200	1200 ~ 1500	1500 ~ 1700

*1 Company A Relay Load: i = 15 mA, τ = approx. 10 ms
*2 Company B Relay Load: i = 27 mA, τ = approx. 25 ms

Breaking Waveform

Bestact Switch



Power Relay
(Magnetic Blowout Type)

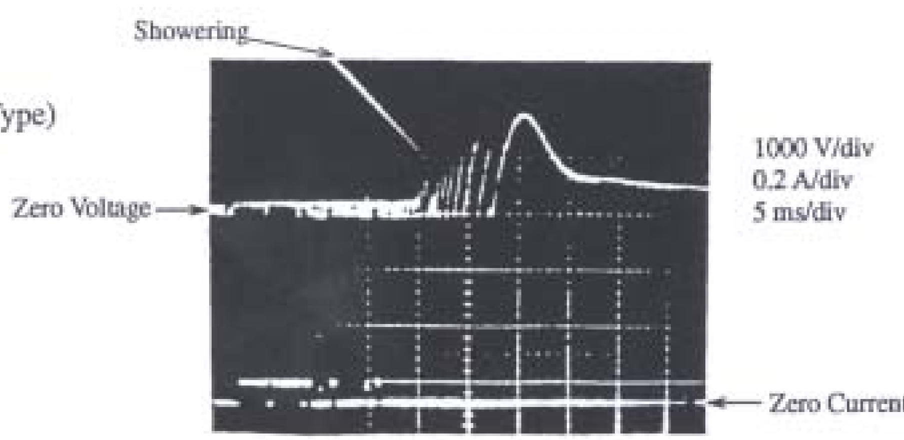


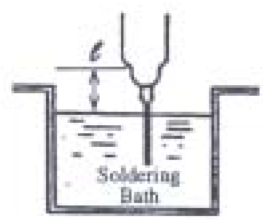
Fig. 16 Breaking Waveform for DC Inductive Load

8. Handling Precautions for Manufacturability

8.1 Soldering Conditions

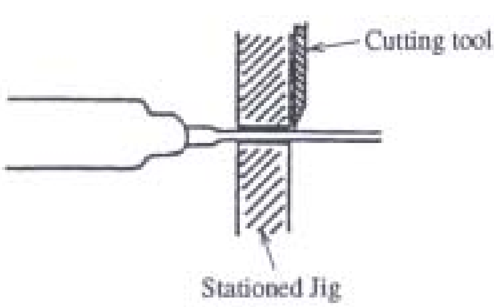
The following table shows the soldering conditions which do not crack the glass nor should affect the operational characteristics of the switch.

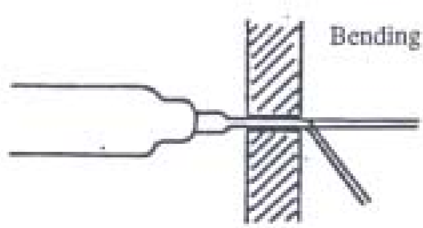
Soldering Temperature	Soldering Position (Distance from Glass Seal)			Remarks
	$\ell = 0$	$\ell = 5$ mm	$\ell = 10$ mm	
260°C	3.5 sec.	8.5 sec.	15 sec.	20 W soldering iron (100 V)
300°C	2.5 sec.	6.0 sec.	11 sec.	20 W soldering iron (110 V)
350°C	2.0 sec.	4.6 sec.	8 sec.	40 W soldering iron (100 V)
400°C	—	4.0 sec.	7 sec.	40 W soldering iron (110 V)



8.2 Cutting and Bending Terminals

When the terminal is subject to manufacturing operation such as cutting, bending and hole insertion, take precautionary measures to properly fix terminal lead within jig so as to not subject hermetic seal of switch to any undue stress.





Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

The terminal lead is part of the actual magnetic circuit. When the terminal lead is cut, the pickup and the dropout ampere-turns will increase as shown below in Fig. 17:

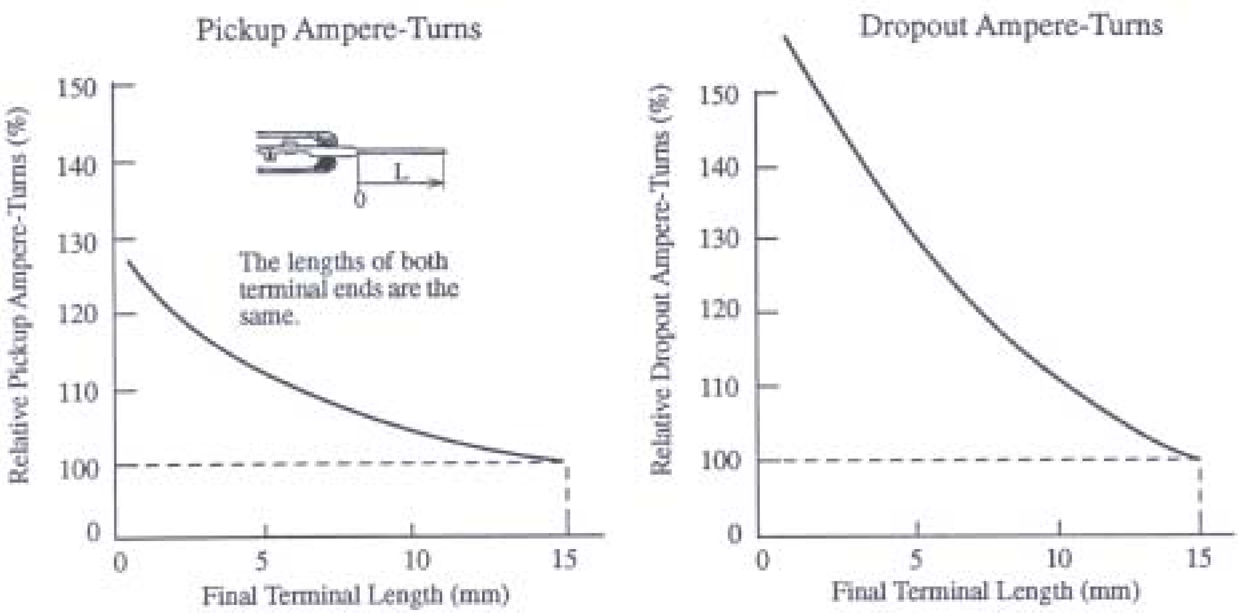


Fig. 17 Terminal Lead Cutting Effect on Pickup and Dropout

Bestact	Bestact Large-Capacity Type Switches (R14 / R15)

9. Measuring Method of Operating Characteristics

Dimensions (mm)

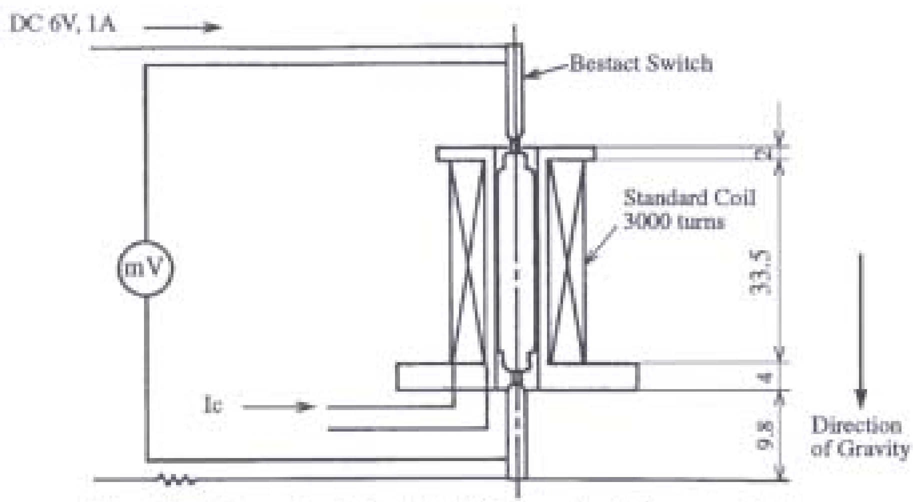


Fig. 18 Measuring Method of Operating Characteristics

Note: 1. Place the elements long axis in parallel with the direction of gravity as shown in the above. Fig. 10.

2. Place the elements so that the center of the coil winding and element (vertical center) coincide. The length of the switch terminal protruding below the lower end of the coil is 9.8 mm in this arrangement.

1.1 Measuring Method of Pickup and Dropout Ampere-Turns

Gradually change the coil current shown in Fig. 10 ($N \frac{di}{dt} = 60$ AT / sec). The Ampere-turn value (3000 turns × Ic) should be the pickup value when the switch is ON and the dropout value when the switch is OFF.

8.2 Measuring Method of Contact Resistance

Impart a current flow of 1A at 6VDC to the contacts as shown in the above Fig. 10. Measure contact resistances by the four-terminal method. Apply a coil current which correlates to 150% of the pickup ampere-turns.

$$\frac{di}{dt} = \frac{60}{3000} \text{ (A / Sec.)}$$

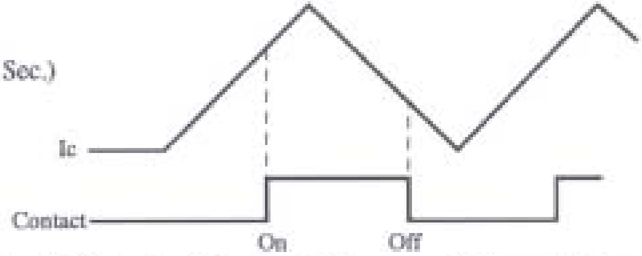


Fig. 19 Graph of Contact Status vs. Coil excitation Current

9.3 Measuring Method of Operating Time

Measure actuation time in the following procedure with the arrangement of Fig. 10.

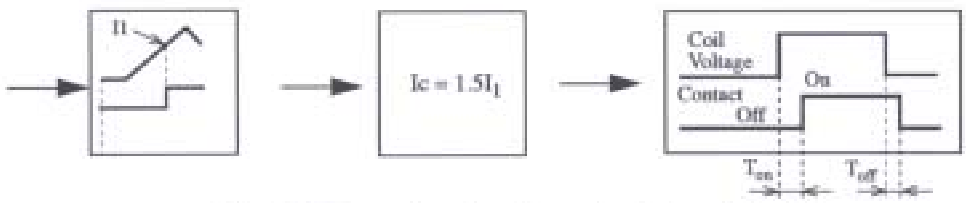


Fig. 20 Procedure for Measuring Operating Time.

Note: A flywheel diode is connected in parallel with the coil when operating time is measured (See to Fig. 13).

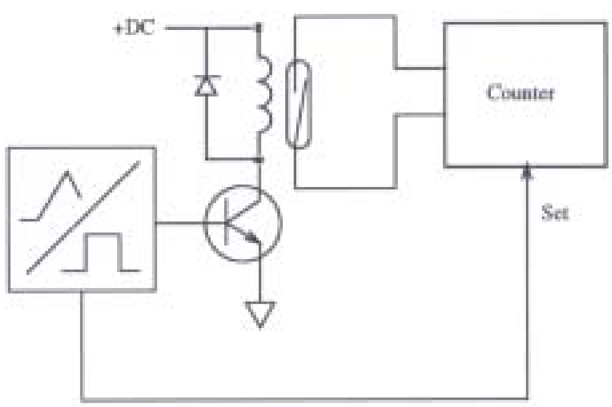


Fig. 21 Circuit Configuration for Measuring Pickup and Dropout Times