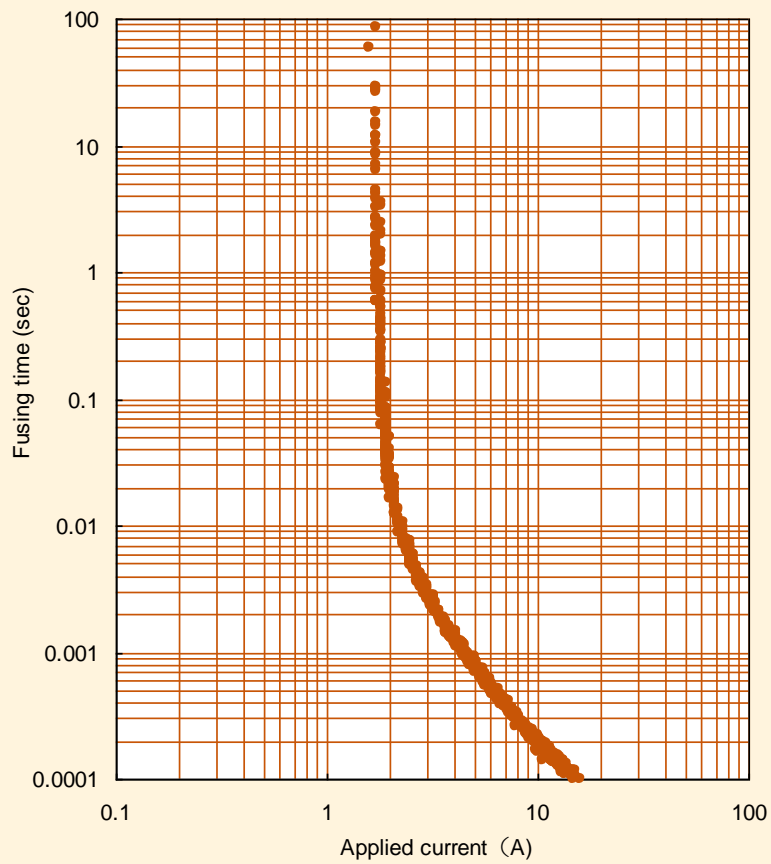


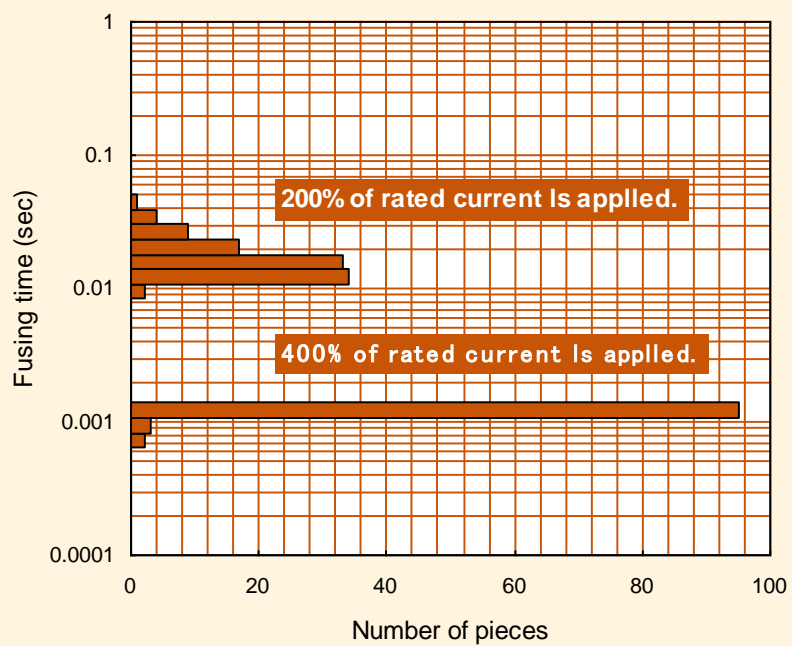
DISTRIBUTION OF FUSING CHARACTERISTICS

KAB 2402 102 n : 1158 pcs.



DISTRIBUTION OF FUSING TIME

KAB 2402 102 n : 100 pcs.



DETERMINATION OF RATED VALUE AND SELECTION OF MICRO FUSE (TYPE KAB)

Determine the rated value of the microfuse, and select the correct microfuse for your circuit. If you select the correct microfuse, safety of your circuit can be ensured.

How to determine the rated value of the microfuse is described below :

■ Flow for fuse selection

1. Measurement of circuit values using acute device

Measure the circuit values, such as operating current of the circuit.

2. Calculation from operating current

From the obtained operating current and the category temperature, calculate the minimum rated value to determine the applicable fuse.

3. Calculation from overload current

From the obtained overload current, calculate the maximum rated value to determine the applicable fuse.

4. Calculation from inrush current

From the inrush current, calculate the minimum rated value to determine the applicable fuse.

5. Final determination of rated value

From the calculation results of steps 2 through 4, determine the rated value.

6. Operation check using actual device

After selecting the rating, confirm if the device works properly under the pre-determined conditions.

■ Fuse selection

1. Measurement of circuit values using actual device

Before determining the rated value of the fuse, preliminarily measure the following using the actual device.

1-1 Operating current

Using an oscilloscope or equivalents, measure the operating current of the circuit.

1-2 Overload current

Using an oscilloscope or equivalents, measure the overload current that needs to break the circuit.

1-3 Inrush current

Using an oscilloscope or equivalents, measure the inrush current of the circuit at power-on or power-off. In addition, determine the number of inrush current applied.

1-4 Category temperature

Measure the ambient temperature of the fuse circuit.

EXAMPLE TO SELECT RATINGS OF TYPE KAB

<Fuse selection>

Effective operating current : 1.2 A

Effective overload current : 6.0 A

Inrush current waveform : Fig. A
(Pulse width : 1 ms, Wave height : 6.0 A)

Numbers to withstand inrush current : 100,000 times

Category temperature : 85°C

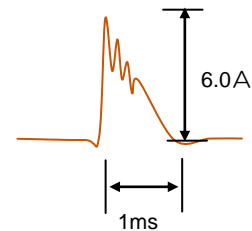


Fig. A : Inrush current waveform

2. Calculation from operating current

2-1 Measurement of operating current

Using an oscilloscope or equivalents, measure operating current (effective current) of the actual circuit.

Example : Effective operating current = 1.2 A

2-2 Derating

① Temperature derating factor

Using Fig. B, find the temperature derating factor correspond to the temperature.

② Rated derating factor

Rated derating factor = 0.75

Use Formula 1 to calculate the rated current of the fuse to be used for the circuit.

Rated current of fuse \geq Operating current / (① \times ②) ... Formula 1)

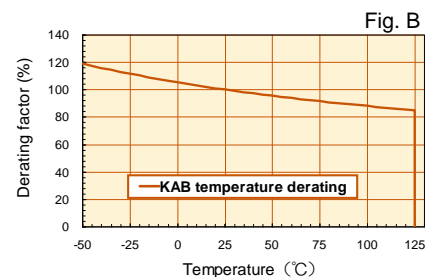
Example : Category temperature = 85°C, Operating current = 1.2 A

① Temperature derating factor = 0.90 (Refer to Fig. B.)

② Rated derating factor = 0.75

Calculation using Formula 1 :

Rated current $\geq 1.2 / (0.90 \times 0.75) = 1.78$ A



The above calculation result shows that the fuse with rated current of 1.78 A or more should be selected for this circuit.

Type KAB with rated current of 2.0 A or more can be selected.

3. Calculation from overload current

3-1 Measurement of overload current

Using an oscilloscope or equivalents, measure the overload current that needs to break the circuit.

Example : Effective overload current = 6.0 A

3-2 Calculation from overload current

Determine the rated current so that the overload current can be 2 times larger than the rated current.

Use Formula 2 to calculate the rated current of the fuse.

Rated current of fuse \leq Overload current/2.0 ... Formula 2

Example : Overload current = 6.0 A

Use Formula 2 to calculate the rated current.

Rated current \leq 6.0/2.0 = 3.0 A

The above calculation result shows that the fuse with rated current of 3.0 A or less should be selected for this circuit.

Type KAB, with rated current of 2.5 A or less can be selected.

4. Calculation from inrush current

4-1 Measurement of inrush current waveform

Using an oscilloscope or equivalent, measure the waveform of the inrush current of the actual circuit.

4-2 Creation of approximate waveform

Generally, the waveform of inrush current is complicated. For this reason, create the approximate waveform of inrush current as shown on Fig. C to simplify calculation.

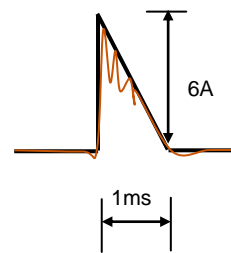


Fig. C : Inrush current waveform
Red line : Actual measurement waveform
Black line : Approximate waveform

4-3 Calculation of I^2t of inrush current

Calculate I^2t (Joule integral) of the approximate waveform.

The formula for this calculation depends on the approximate waveform.

Refer to Table A.

Example : Pulse applied = 1 ms, Peak value = 6.0 A,

Approximate waveform = Triangular wave

Since the approximate waveform is a triangular wave, use the following formula for calculation

I^2t of rush current = $1/3 \times I_m^2 \times t$... Formula 3

(I_m : Peak value, t : Pulse applying time)

Use Formula 3 to calculate the I^2t of the rush current :

$$I^2t = 1/3 \times 6 \times 6 \times 0.001 = 0.012 \text{ (A}^2\text{s)}$$

JOULE-INTEGRAL VALUES FOR EACH WAVEFORM

Table A

Name	Waveform	I^2t	Name	Waveform	I^2t
Sine wave (1 cycle)		$\frac{1}{2} I_m^2 t$	Trapezoidal wave		$\frac{1}{3} I_m^2 t_1 + I_m^2 (t_2 - t_1) + \frac{1}{3} I_m^2 (t_3 - t_2)$
Sine wave (half cycle)		$\frac{1}{2} I_m^2 t$	Various wave 1		$I_1 I_2 t + \frac{1}{3} (I_1 - I_2)^2 t$
Triangular wave		$\frac{1}{3} I_m^2 t$	Various wave 2		$\frac{1}{3} I_1^2 t_1 + \{I_1 I_2 + \frac{1}{3} (I_1 - I_2)^2\} (t_2 - t_1) + \frac{1}{3} I_2^2 (t_3 - t_2)$
Rectangular wave		$I_m^2 t$	Charge/discharge waveform		$\frac{1}{2} I_m^2 \tau$

* Following formula is generally used for calculation of I^2t as $i(t)$ equal to current.

$$I^2t = \int_0^t i^2(t) dt$$

4-4 Search of load ratio

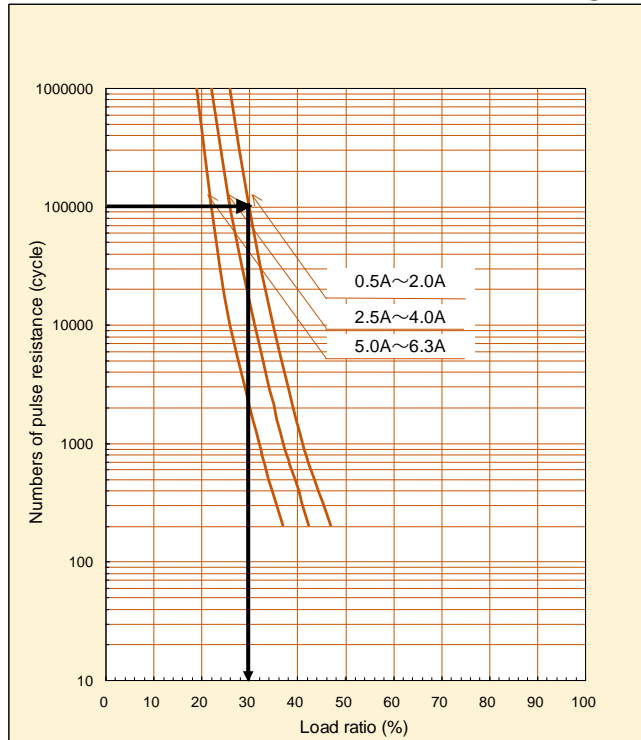
- ① Set up the number of cycles to withstand. (generally 100,000 times)
- ② Obtain the load ratio from Pulse resistance characteristics. (Fig. D)

Example : 100,000 times is required against inrush current applied.

Determine the load ratio using Fig. D.
 If the rated current is 0.2 ~ 2.0 A : 30% or less
 If the rated current is 2.5 ~ 4.0 A : 26% or less
 If the rated current is 5.0 ~ 6.3 A : 22% or less

PULSE RESISTANCE CHARACTERISTICS

Fig. D



4-5 Calculation from Joule integral and load ratio

Use Formula 4 to calculate the standard I^2t for the fuse to be used.

Standard I^2t of fuse > (I^2t of inrush current/load ratio)
Formula 4

Example : I^2t of pulse = 0.012 A²s,
 Required load ratio = 30% (at 0.2 ~ 2.0 A Fuse),
 26% (at 2.5 ~ 4.0 A Fuse) or
 22% (at 5.0 ~ 6.3 A Fuse)

Example of 2.0 A Fuse : Use Formula 4 to calculate the standard I^2t of fuse.
 Standard I^2t of fuse > 0.012/0.3 = 0.04 (A²s)

The standard I^2t of the fuse should be 0.04 (A²s) or more.

Since the rush pulse applied is 1 ms, obtain the intersection of 1 ms (horizontal axis) and 0.04 A²s (vertical axis) from Fig. E (refer to the arrow shown on Fig. E).

*Fig. E shows the Joule integral curves for size 1608. For size 2012, use the Joule integral curves for the size.

Select a fuse whose curve is above the intersection. Type KAB, with rated current of 1.6 A or more should be selected.

5. Final determination of rated value

Determine the rated current of the microfuse. The rated current should meet all the above calculation results.

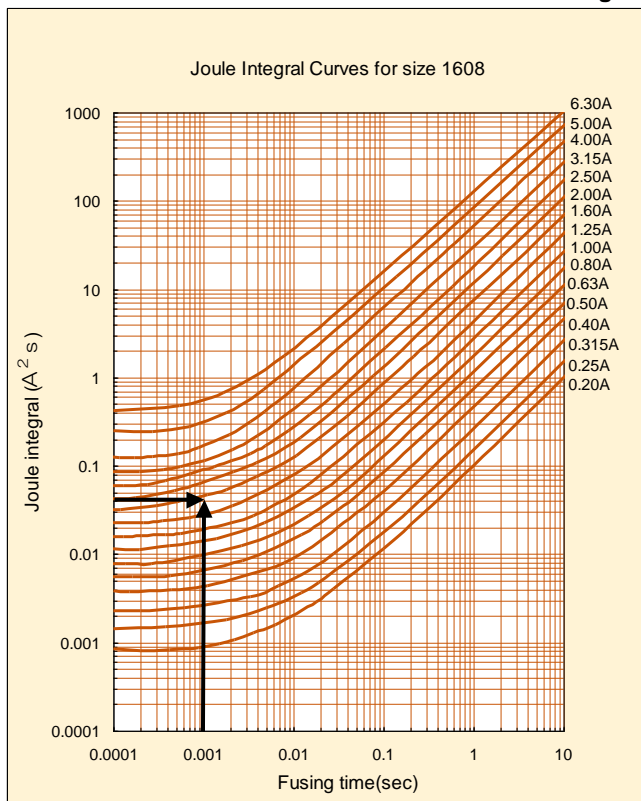
Example : Rated current of 2.0 A and 2.5 A meet the all requirements.

6. Operation check using actual device

After selecting the rating, confirm if the device works properly under the pre-determined conditions.

JOULE INTEGRAL VS. FUSING TIME

Fig. E



Application Notes for Micro Fuse

1. Circuit Design

Micro Fuse should be designated only after confirming operating conditions and the Micro Fuse performance characteristics.

When determining the rated current, be sure to observe the following items :

- (1) Micro Fuse should always be operated below the rated current (the value considered in the temperature derating rate) and voltage specifications. According to item 2,2-2 in page 7.
- (2) Micro Fuse should always be operated below the rated voltage.
- (3) Micro Fuse should be selected with correct rated value to be fused at overload current.
- (4) When Micro Fuse are used in inrush current applications, please confirm sufficiently inrush resistance of Micro Fuse.
- (5) Please do not apply the current exceeding the breaking current to Micro Fuse.
- (6) Use Micro Fuse under the condition of category temperature.
- (7) Micro Fuse should not be used in the primary power source.

Micro Fuse should be selected by determining the operating conditions that will occur after final assembly, or estimating potential abnormalities through cycle testing.

2. Assembly and Mounting

During the entire assembly process, observe Micro Fuse body temperature and the heating time specified in the performance table. In addition, observe the following items :

- (1) Mounting and adjusting with soldering irons are not recommendable since temperature and time control is difficult.
In case of emergency for using soldering irons, be sure to observe the conditions specified in the performance table.
- (2) Micro Fuse body should not have direct contact with a soldering iron.
- (3) Once Micro Fuse mounted on the board, they should never be remounted on boards or substrates.
- (4) During mounting, be careful not to apply any excessive mechanical stresses to the Micro Fuse.

3. Solvents

For cleaning of Micro Fuse, immersion in isopropyl alcohol for 90 seconds (at 20 ~ 30°C liquid temp.) will not be damaged.

If organic solvents (Pine Alpha™, Techno Care™, Clean Through™, etc.) will be applied to the Micro Fuse, be sure to preliminarily check that the solvent will not damage the Micro Fuse.

4. Ultrasonic Cleaning

Ultrasonic cleaning is not recommended for Micro Fuse. This may cause damage to the Micro Fuse such as broken terminals which results in electrical characteristics effects, etc. depending on the conditions.

If Ultrasonic cleaning process must be used, please evaluate the effects sufficiently before use.

5. Caution During Usage

- (1) Micro Fuse with electricity should never be touched. Micro Fuse with electricity may cause burning due to the Micro Fuse high temperature. Also, in case of touching Micro Fuse without electricity, please check the safety temperature of Micro Fuse.
- (2) Protective eyeglasses should always be worn when performing fusing tests. However, there is a fear that Micro Fuse will explode during test. During fusing tests, please cover particles not to fly outward from the board or testing fixture. Caution is necessary during usage at all times.

6. Environmental Conditions

- (1) Micro Fuse should not be operated in acid or alkali corrosive atmosphere.
- (2) Micro Fuse should not be vibrated, shocked, or pressed excessively.
- (3) Micro Fuse should not be operated in a flammable or explosive atmosphere.
- (4) After mounting Micro Fuse on a board, covering Fuses with resin may affect to the electric characteristics of the Micro Fuse. Please be sure to evaluate it in advance.

7. Emergency

In case of fire, smoking, or offensive odor during operation, please cut off the power in the circuit or pull the plug out.

8. Storage

- (1) Micro Fuse should be stored at room temperature (-10°C ~ +40°C) without direct sunlight but not in corrosive atmosphere such as H₂S (hydrogen sulfide) or SO₂ (sulfur dioxide). Direct sunlight may cause decolorization and deformation of the exterior and taping. Also, there is a fear that solderability will be remarkably lower in high humidity.
- (2) If the products are stored for an extended period of time, please contact Matsuo Sales Department for recommendation. The longer storage term causes packages and tapings to worsen. If the products are stored for longer term, please contact Matsuo Sales Department for advice.
- (3) The products in taping, package, or box should not be given any kind of physical pressure. Deformation of taping or package may affect automatic mounting.

9. Disposal

When Micro Fuse are disposed of as waste or "scrap", they should be treated as "industrial waste". Micro Fuse contain various kinds of metals and resins.

10. Samples

Micro Fuse received as samples should not be used in any products or devices in the market. Samples are provided for a particular purpose such as configuration, confirmation of electrical characteristics, etc.



MATSUO ELECTRIC CO., LTD.

Please feel free to ask our sales department for more information on the Micro Fuse.

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Head office 5-3,3-Chome,Sennari-cho,Toyonaka-shi,Osaka 561-8558,Japan Tel : 06-6332-0871 Fax : 06-6331-1386
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