TYPE KAB

Type KAB micro fuse is designed for circuit protection against excessive current in portable electronic equipment, electronic circuit around battery, etc. because the demand for high capacity batteries is increasing.
Further miniaturization and low profile with extended rated range can be used for wider application.
Also, the ecology design of Type KAB is friendly to environment due to complete lead free.

FEATURES

1. New type fuses developed by our original technology. They show no variation in fusing characteristics and have excellent fastblow capability.
2. Surface temperature rise is 75°C or less when applying rated current. This offers less influence on the peripheral units.
3. The fuses come in ultrasmall size 1608 (1.6×0.8×0.45 mm) and 2012 (2.0×1.25×0.5 mm).
4. Suitable for automatic mounting
5. Precise dimensions allows high-density mounting and symmetrical construction of terminals provide “Self-Alignment”.
6. Resistance to soldering heat : Reflow or flow soldering 10 seconds at 260°C
7. High accuracy carrier tape by using pressed pocket paper ensures excellent mounting.
8. LEAD-FREE and RoHS Compliant

RATING

Item	Rating	
Category Temperature Range	-40 ～ +125℃	
Rated Current	1.6×0.8	0.2-0.25-0.315-0.4-0.5-0.63-0.8-1.0-1.25-1.6-2.0-2.5-3.15-4.0-5.0-6.3A
	2.0×1.25	0.2-0.25-0.315-0.4-0.5-0.63-0.8-1.0-1.25-1.6-2.0-2.5-3.15-4.0-5.0A
Rated Voltage	24VDC, 32VDC, 50VDC	
Voltage Drop	Refer to CATALOG NUMBERS AND RATING	
Insulation Resistance (between Terminals and Case)	1000MΩ or more	
Fusing Characteristics	Fusing within 1 min if the current is 200% of rated current.	
Clearing Characteristics	Breaking voltage：24V, 32V, 50V	
	Breaking current：50A	

ORDERING INFORMATION

KAB 3202 102 NA 29 010

Type
KAB

Code	Voltage
2402	24V
3202	32V
5002	50V

Code	Rated current	Code	Rated current
201	0.2 A	132	1.25 A
251	0.25 A	162	1.6 A
321	0.315 A	202	2.0 A
401	0.4 A	252	2.5 A
501	0.5 A	322	3.15 A
631	0.63 A	402	4.0 A
801	0.8 A	502	5.0 A
102	1.0 A	632	6.3 A

Code	Packaging type
NA	φ180 Real

Code	Case size
29	1.6 × 0.8
31	2.0 × 1.25

Special product code
010※

※ The special product code 010 indicates lead-free terminals.

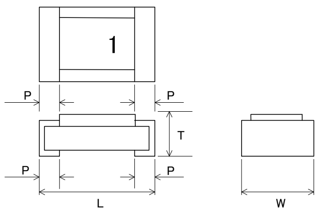
CATALOG NUMBERS AND RATING

November, 2010

Catalog number	Case size	Rated current A	Internal resistance mΩ (Typical)	Voltage drop mV (Max.)	Rated voltage VDC	Breaking current A
KAB 5002 201 □□29 010※	1.6×0.8	0.2	1260	405	50	50
KAB 5002 251 □□29 010	1.6×0.8	0.25	825	355		
KAB 5002 321 □□29 010	1.6×0.8	0.315	530	275		
KAB 5002 401 □□29 010	1.6×0.8	0.4	320	180		
KAB 5002 501 □□29 010	1.6×0.8	0.5	210	140		
KAB 3202 631 □□29 010	1.6×0.8	0.63	135	115	32	
KAB 3202 801 □□29 010	1.6×0.8	0.8	100	110		
KAB 3202 102 □□29 010	1.6×0.8	1.0	80	110		
KAB 3202 132 □□29 010	1.6×0.8	1.25	60	110		
KAB 3202 162 □□29 010	1.6×0.8	1.6	46	110		
KAB 3202 202 □□29 010	1.6×0.8	2.0	35	110		
KAB 2402 252 □□29 010	1.6×0.8	2.5	27	110	24	
KAB 2402 322 □□29 010	1.6×0.8	3.15	20	110		
KAB 2402 402 □□29 010	1.6×0.8	4.0	15	110		
KAB 2402 502 □□29 010	1.6×0.8	5.0	13	110		
KAB 2402 632 □□29 010	1.6×0.8	6.3	10	110		
KAB 2402 201 □□31 010	2.0×1.25	0.2	1740	480	24	50
KAB 2402 251 □□31 010	2.0×1.25	0.25	1280	475		
KAB 2402 321 □□31 010	2.0×1.25	0.315	800	375		
KAB 2402 401 □□31 010	2.0×1.25	0.4	440	255		
KAB 2402 501 □□31 010	2.0×1.25	0.5	260	170		
KAB 2402 631 □□31 010	2.0×1.25	0.63	175	150		
KAB 2402 801 □□31 010	2.0×1.25	0.8	120	145		
KAB 2402 102 □□31 010	2.0×1.25	1.0	90	135		
KAB 2402 132 □□31 010	2.0×1.25	1.25	67	130		
KAB 2402 162 □□31 010	2.0×1.25	1.6	48	120		
KAB 2402 202 □□31 010	2.0×1.25	2.0	36	115		
KAB 2402 252 □□31 010	2.0×1.25	2.5	28	110		
KAB 2402 322 □□31 010	2.0×1.25	3.15	21	105		
KAB 2402 402 □□31 010	2.0×1.25	4.0	16	95		
KAB 2402 502 □□31 010	2.0×1.25	5.0	10	60		

※For taping specification, the package code (NA) is entered □□. One reel contains 5000 pcs.
UL/cUL approved File No.E17021

DIMENSIONS



Main Body : Alumina ceramic
Terminal : Tin plating

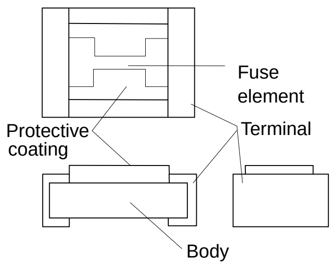
(mm)

Case size	Case code	L	W	T max.	P
1608	29	1.6 ± 0.1	0.8 ± 0.1	0.45	0.3 ± 0.2
2012	31	2.0 ± 0.1	1.25 ± 0.1	0.5	0.3 ± 0.2

MARKING

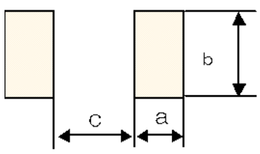
Code	Rated current	Code	Rated current
P	0.2 A	W	1.25 A
Q	0.25 A	X	1.6 A
R	0.315A	2	2.0 A
S	0.4 A	Y	2.5 A
T	0.5 A	3	3.15 A
U	0.63 A	4	4.0 A
V	0.8 A	5	5.0 A
1	1.0 A	6	6.3 A

CONSTRUCTION



Name	Material
Fuse element	Copper alloy
Body	Alumina ceramic
Protective coating	Silicone resin
Terminal	Tin plating

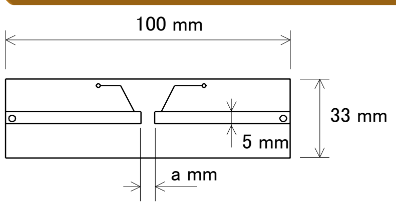
RECOMMENDED PAD DIMENSIONS



	Size 1608	Size 2012
a	1.0	1.4
b	1.2	1.65
c	1.0	1.2

(mm)

STANDARD TEST BOARD



Glass epoxy on one side
Board thickness : 1.6mm
Copper layer : 35µm

Case size	Size a
1608	1.2
2012	1.5

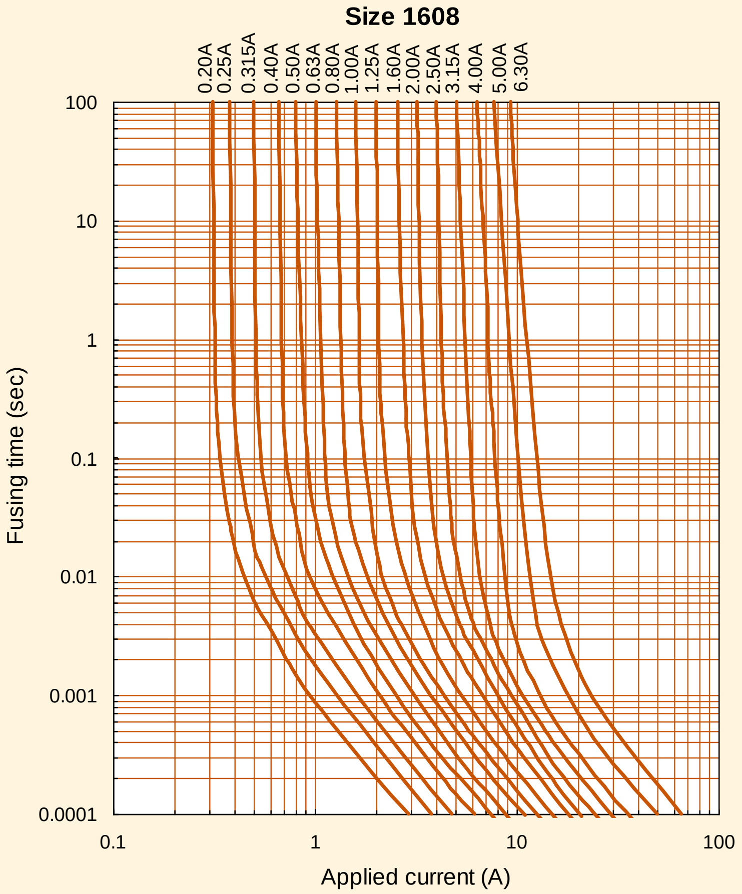
(mm)

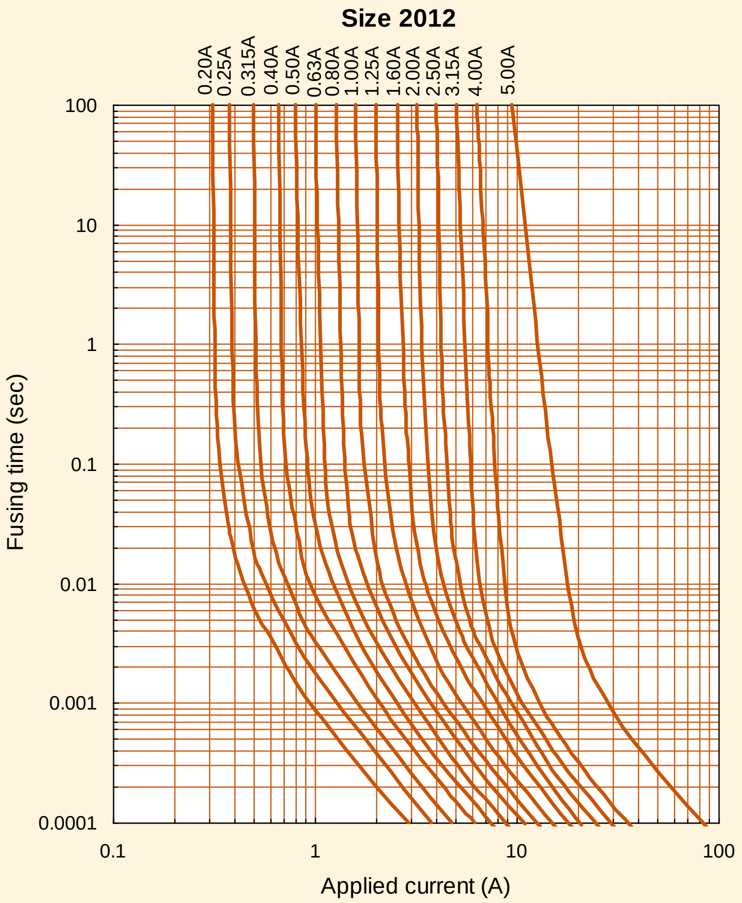
PERFORMANCE

No.	Item	Performance	Test method
1	Temperature rise	Temperature rise shall not exceed 75°C.	Apply rated current.
2	Current-carrying capacity	Shall not open within 1 hour.	Apply rated current.
3	Clearing characteristics	Arc shall not be continued. Marking shall be legible.	Breaking voltage : Rated voltage Breaking current : 50 A
4	Voltage drop	Voltage drop is below the value specified in CATALOG NUMBERS AND RATING.	Apply rated current.
5	Fusing characteristics	Fusing within 1 min.	Apply 200% of rated current. (Ambient temperature : 10 ~ 30°C)
6	Insulation resistance	1000 MΩ or more	Insulation resistance between terminals and case (alumina ceramic)
7	Electrode strength (Bending)	No mechanical damage. Resistance change after the test shall be within ± 20%	Board supporting width : 90 mm Bending speed : Approx. 0.5 mm/sec Duration : 30 sec Bending : 3 mm
8	Shear test	No mechanical damage. Resistance change after the test shall be within ± 20%	Applied force : 20 N (2.04 kgf) Duration : 10 sec Tool : R0.5 Direction of the press : side face
9	Substrate bending test	No mechanical damage. Resistance change after the test shall be within ± 20%	Supporting dimension : 1.2 mm (size 2012) 0.8 mm (size 1608) Applied force : 10 N (1.02 kgf) Tool : R0.5 Direction of the press : thickness direction of product
10	Solderability (Solder Wetting time)	Solder Wetting time : within 3sec.	Solder : Sn–3Ag–0.5Cu Temperature : 245 ± 3°C meniscograph method Solder : JISZ3282 H60A, H60S, H63A Temperature : 230 ± 2°C meniscograph method
11	Solderability (new uniform coating of solder)	The dipping surface of the terminals shall be covered more than 95% with new solder.	Solder : Sn–3Ag–0.5Cu Temperature : 245 ± 3°C Dipping : 3 sec. Solder : JISZ3282 H60A, H60S, H63A Temperature : 230 ± 2°C Dipping : 3 sec.
12	Resistance to soldering heat	Marking shall be legible. No mechanical damage. Resistance change after the test shall be within ± 20%	Dipping (1 cycle) Preconditioning : 100 ~ 150°C, 60 sec Temperature : 265 ± 3°C /6 ~ 7 sec Reflow soldering (2 cycles) Preconditioning : 1 ~ 2 min, 180°C or less Peak : 260°C max, 5 sec Holding : 230 ~ 250°C, 30 ~ 40 sec Cooling : more than 2 min Manual soldering Temperature : 400 ± 10°C Duration : 3 ~ 4 sec Measure after 1 hour left under room temp. and humidity.
13	Solvent resistance	Marking shall be legible. No mechanical damage. Resistance change after the test shall be within ± 20%	Dipping rinse Solvent : Isopropyl alcohol Duration : 90 sec
14	Ultrasonic Cleaning	Marking shall be legible. No mechanical damage. Resistance change after the test shall be within ± 20%	Ultrasonic : 20mW/cm^2 28kHz Solvent : Isopropyl alcohol Duration : 60 sec
15	Vibration	No mechanical damage. Resistance change after the test shall be within ± 20%	Frequency range : 10 ~ 55 ~ 10 Hz/min Vibration amplitude : 1.5 mm Duration : 2 hours in each of XYZ directions (total : 6 hours)
16	Shock	No mechanical damage. Resistance change after the test shall be within ± 20%	Peak value : 490 m/s^2 (50 G) Duration : 11 m sec 6 aspects × 3 times (total : 18 times)
17	Thermal shock	No mechanical damage. Resistance change after the test shall be within ± 20%	–55 ± 3°C : 30 min Room temperature : 2 ~ 3 min or les 125 ± 2°C : 30 min Room temperature : 2 ~ 3 min or less Repeat above step for 10 cycles.
18	Atomizing salt water	No mechanical damage. Resistance change after the test shall be within ± 20%	Temperature : 35 ± 2°C Concentration (weight ratio) : 5 ± 1% Duration : 24 hours
19	Moisture resistance	No mechanical damage. Resistance change after the test shall be within ± 20%	Temperature : 85 ± 3°C Humidity : 85 ± 5% RH Duration : 1000 hours
20	Load life	No mechanical damage. Resistance change after the test shall be within ± 20%	Temperature : 85 ± 2°C Applied current : Rated current × 70% Duration : 1000 hours
21	Stability	No mechanical damage. Resistance change after the test shall be within ± 20%	Temperature : 125 ± 2°C Duration : 1000 hours
22	Accelerated damp heat steady state	No mechanical damage. Resistance change after the test shall be within ± 20%	Temperature : 85 ± 3°C Humidity : 85 ± 5% RH Applied current : Rated current × 70% Duration : 1000 hours

FUSING CHARACTERISTICS

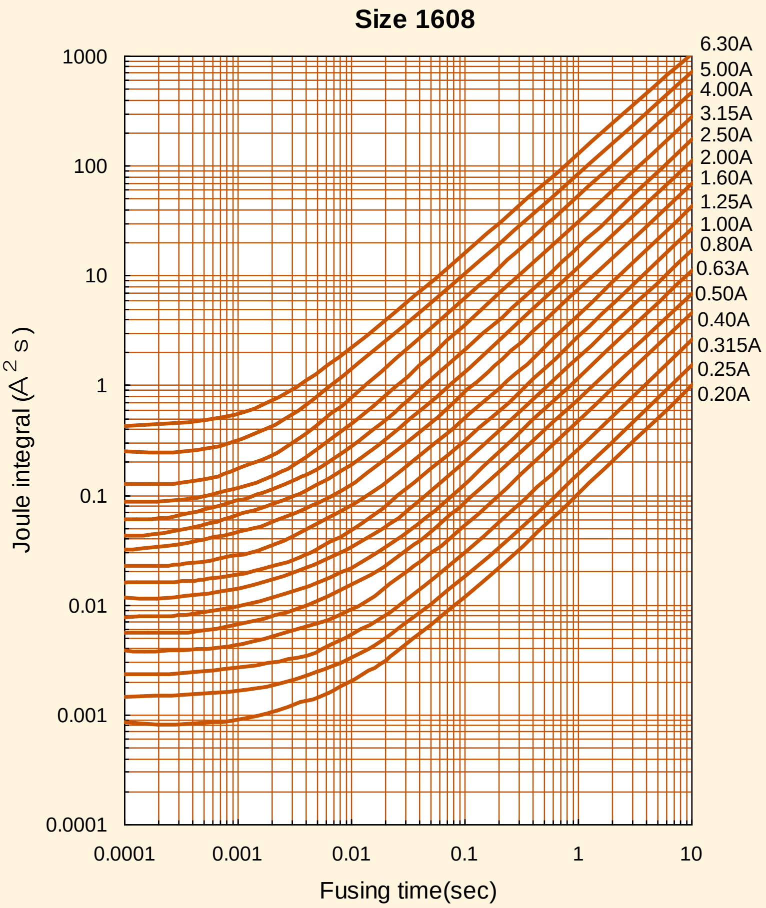
Reference

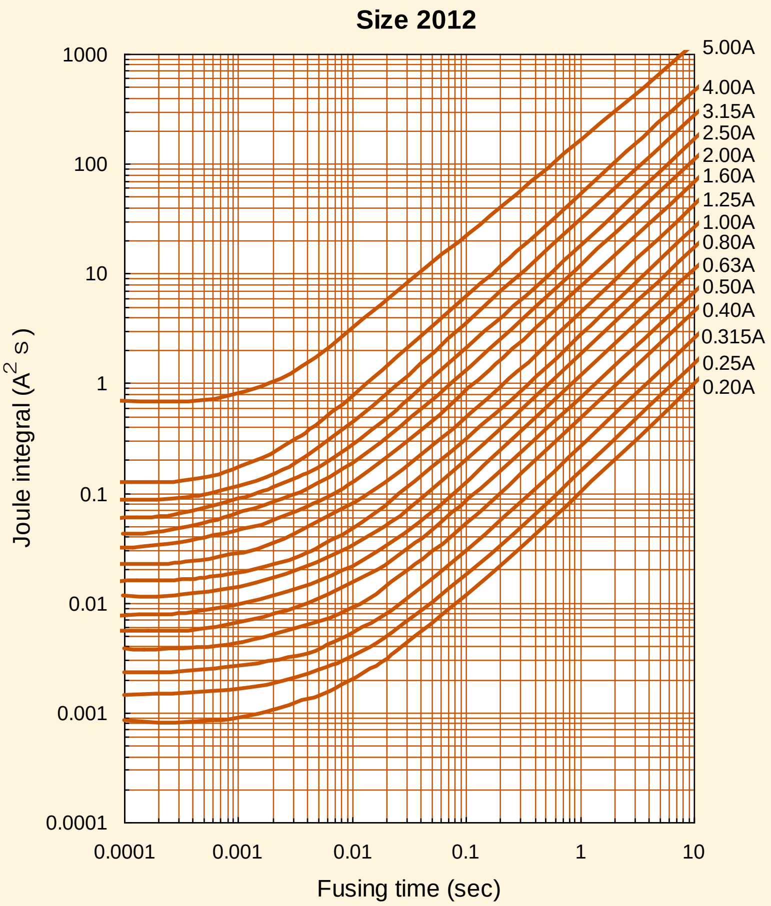




I^2T–T CHARACTERISTICS

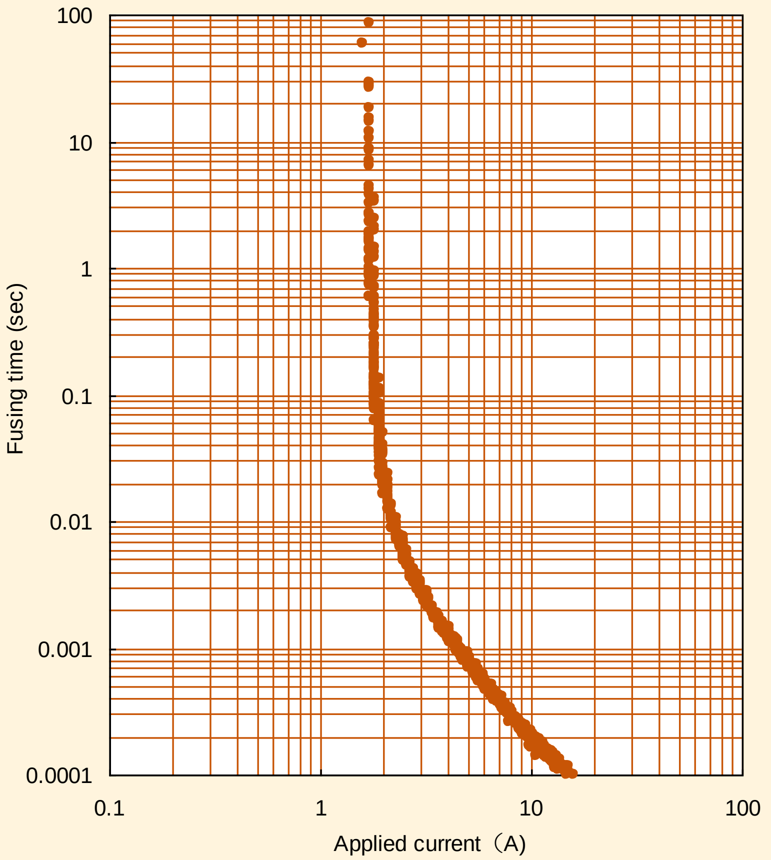
Reference





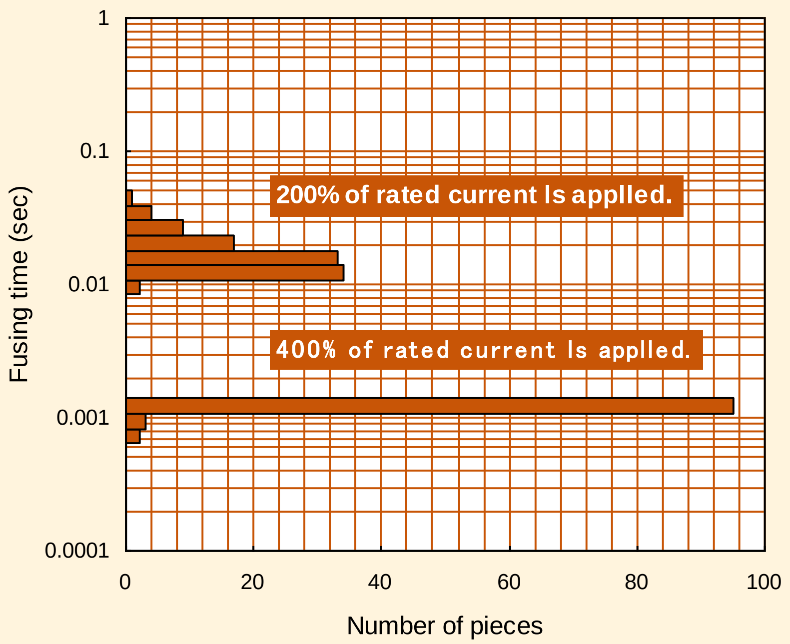
DISTRIBUTION OF FUSING CHARACTERISTICS

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

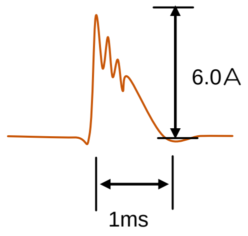


Fig. A : Inrush current waveform

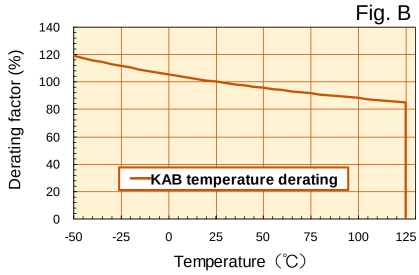
2. Calculation from operating current

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
①Temperature derating factor
Using Fig. B, find the temperature derating factor correspond to the temperature.
②Rated 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 ≥ Operating current/ (①×②) ... Formula 1)

Fig. B



Example : Category temperature = 85°C, Operating current = 1.2 A
①Temperature derating factor = 0.90 (Refer to Fig. B.)
②Rated derating factor = 0.75
Calculation using Formula 1 :
Rated current ≥ 1.2/ (0.90×0.75) = 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 ≤ Overload current/2.0 ... Formula 2

Example : Overload current = 6.0 A
Use Formula 2 to calculate the rated current.
Rated current ≤ 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.

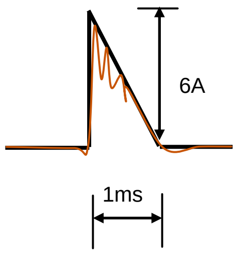


Fig. C : Inrush current waveform
Red line : Actual measurement waveform
Black line : Approximate waveform

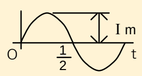
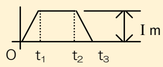
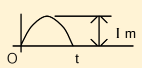
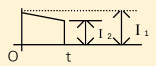
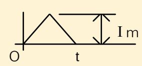
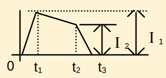
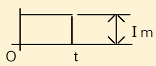
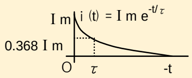
4–3 Calculation of I^2t of inrush current

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 × Im^2 × t ... Formula 3
(Im : Peak value, t : Pulse applying time)
Use Formula 3 to calculate the I^2t of the rush current :
$I^2t = 1/3 \times 6 \times 6 \times 0.001 = 0.012$ (A^2s)

JOULE-INTEGRAL VALUES FOR EACH WAVEFORM

Table A

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

∗ 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

①Set up the number of cycles to withsand. (generally 100,000 times)

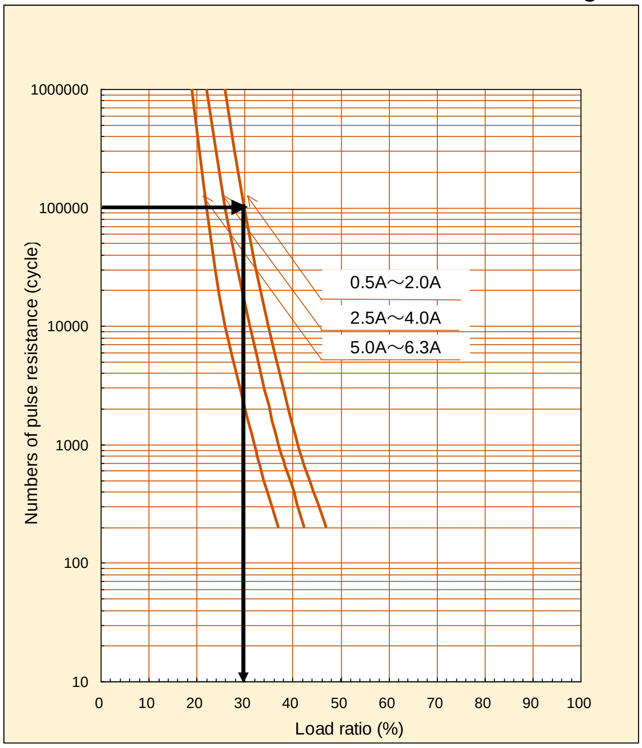
②Obtain the load ratio from Pulse resistance characteristics. (Fig. D)

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 CHARACTERISTCS

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 A^2s,
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 (A^2s)

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

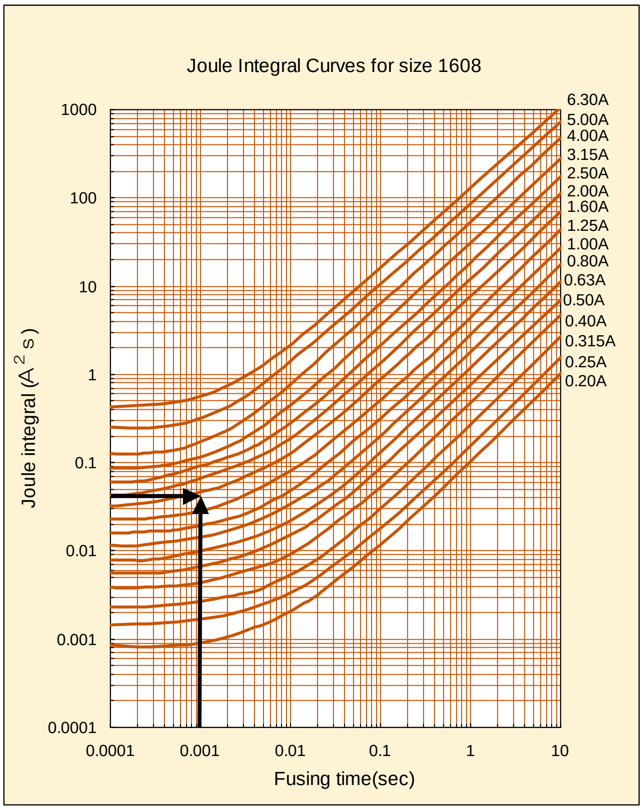
Since the rush pulse applied is 1 ms, obtain the intersection of 1 ms (horizontal axis) and 0.04 A^2s (vertical axis) from Fig. E (refer to the arrow shown on Fig. E).

∗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.

JOULE INTEGRAL VS. FUSING TIME

Fig. E



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.

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^{TM}, Techno Care^{TM}, Clean Through^{TM}, 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 H_2S (hydrogen sulfide) or SO_2 (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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